Department of The Navy

Science and Technology Requirements Guidance

STRG

The Office of the Chief of Naval Operations
Director, Test and Evaluation and Technology Requirments (N091)
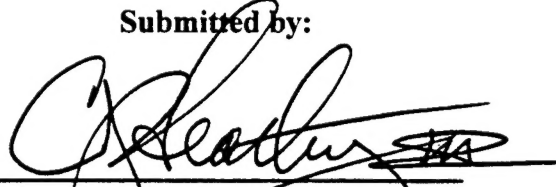
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The Science and Technology Requirements Guidance (STRG) is to provide the technology community--particularly the Office of Naval Research--with a consolidated set of Navy and Marine Corps requirements. This guidance should be used for planning 6.1, 6.2 and 6.3 programs.

In FY 1995, panels in 11 Joint Mission Areas and Support Areas (JMA/SAs) met to assess broad naval needs in their respective domains. The S&T Round Tables, using the same 11 categories plus medical technology, gathered operational personnel, headquarters staff, and technologists to identify and prioritize S&T requirements that would be delivered as capabilities to the fleet 7 to 20 years from now. The STRG is based on conclusions from the Round Tables plus direct fleet input through the inclusion of the consolidated CINC Command Technology Issues.

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SCIENCE AND TECHNOLOGY REQUIREMENTS GUIDANCE (STRG)

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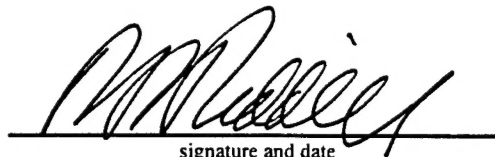
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Science and Technology Requirements Guidance

Executive Summary

Purpose

The purpose of the Science and Technology Requirements Guidance (STRG) is to provide the technology community--particularly the Office of Naval Research--with a consolidated set of Navy and Marine Corps requirements. This guidance should be used for planning 6.1, 6.2 and 6.3 programs.

Background

In FY 1995, panels in 11 Joint Mission Areas and Support Areas (JMA/SAs) met over a period of many weeks to assess broad naval needs in their respective domains. The S&T Round Tables, using the same 11 categories plus medical technology, gathered operational personnel, headquarters staff, and technologists to identify and prioritize S&T requirements that would be delivered as capabilities to the fleet 7 to 20 years from now. The STRG is based on conclusions from the Round Tables plus direct fleet input through the inclusion of the consolidated CINC Command Technology Issues.

Strategic Vision

The STRG identifies and prioritizes requirements for S&T to support attainment of a set of broad objectives or strategic vision statements from each JMA/SA plus medical:

- Joint Strike Warfare--Affordable systems that achieve the desired damage on targets in all environments at any time while minimizing own losses.
- Joint Littoral Warfare--Ability to dominate the sea, air and land battlespace rapidly and cost effectively in order to project power with a minimum of casualties.
- Joint Surveillance--Ability to provide the joint warfighting commander with timely, accurate information through systematic observation of the battlespace.
- Joint SEW / Intelligence--Battlespace dominance through use of the right information at the right place and at the right time, and denial of the same to the enemy.
- Strategic Deterrence--Ability to dissuade an adversary from acting contrary to U.S. vital interests through credible threat, perception that cost would exceed gain, or expectation of failure.
- Maritime Support of Land Forces--Sustainment of forces via affordable strategic sealift and combat logistics capabilities to ensure timely delivery of cargoes into littoral regions.

- Forward Presence--Forward naval forces that can protect U.S. interests, deter aggression, enhance regional stability, improve interoperability with allies, and provide timely crisis response.
- Readiness--Ability of naval forces, units, weapons and equipment to perform as intended by measuring present readiness, forecasting requirements and applying resources.
- Support and Infrastructure--Ability to determine what is necessary to support peacetime readiness and wartime employment of the planned naval combat force structure.
- Manpower and Personnel--Advanced technology to manage DoN's most important resource-- the person--and to improve human-system performance.
- Training--Attainment of optimum mission readiness through individual and team training that is adaptable, responsive, global, efficient and consistent.
- Medical--Ability to provide optimal global medical responsiveness for prevention, protection, diagnosis and treatment.

Cross-JMA/SA Requirements

During the Round Table process, certain issues arose in numerous contexts. Requirements in the following areas were the most prevalent:
- Battlespace awareness--Communication with own, joint and allied forces; knowledge of location and status of all forces; fusion of data into usable information; surveillance; battle damage assessment.
- Precision attack/targeting--Location, monitoring, identification and classification of potential targets; reduction of weapons required; limitation of collateral damage; functional destruction of targets.
- Survivability--Threat detection and avoidance; signature reduction; countermeasures; weapons accuracy, speed, range and lethality; platform hardening; personnel protection; damage-control equipment and procedures.
- Supply--Material support, transportation support, cargo handling.
- Training--Mission training and rehearsal tools to enable flexible response.
- Joint operations--Elimination of barriers (systemic, doctrinal, language, cultural) to effective joint operations.
- Environment--Oceanographic and meteorological factors and their effects on sensors, systems and operations (own-force and adversary); use of environmentally harmless materials, systems and procedures.

The FY 1995 STRG reflects careful evaluation of Round Table findings and fleet input. Although the document's longer-term perspective limits year-to-year shifts in requirements, some changes in emphasis have occurred since the previous STRG due to maturation of the requirements-setting process. In addition, changes in DoN's budget continue to alter force composition, policy, plans and missions in ways that affect S&T requirements. Continued operational effectiveness will depend not only on the traditional dedication of the operational community, but also upon the S&T community's creative response to fleet needs as set forth in the STRG.

Section I

Introduction

Purpose

The Science and Technology Requirements Guidance (STRG) identifies, describes and prioritizes desired capabilities for naval operations 7 to 20 years in the future. This document provides the technology community--particularly the Office of Naval Research--with a consolidated set of Navy and Marine Corps requirements. These requirements provide planning guidance for science and technology (S&T) programs in the Department of the Navy (DoN), which includes basic research (6.1), exploratory development (6.2) and advanced development (6.3). They also provide a foundation for other Program 6 efforts, for industry independent research and development (IRAD) programs, for understanding fleet concerns and for prioritizing competitive science and technology programs.

The STRG is the source document from which the Director, Test and Evaluation and Technology Requirements (N091) prepares (1) the annual Technology Base Guidance for the Chief of Naval Research and (2) the Advanced Technology Demonstration Guidance for the Chief of Naval Research, for Navy laboratories and Centers, for Federally Funded Research and Development Centers, and for commercial industry. The STRG serves as DoN's definitive technology-requirements document for use by the Director of Defense Research and Engineering (DDR&E) in developing a coordinated Department of Defense (DoD) technology program and investment strategy. It also identifies technology-transition opportunities for the Advanced Research Projects Agency (ARPA).

Products of DoN science and technology aid in the acquisition of new fleet systems in three ways:
- They provide incremental improvements to existing systems (e.g., more accurate guns).
- They provide new capabilities to meet warfighting needs (e.g., over-the-horizon targeting).
- They provide new options for meeting military objectives (e.g., laser weapons).

Methodology

The primary method of defining DoN S&T requirements is the S&T round table process, initiated and managed by the Director of Navy Test and Evaluation and Technology Requirements (N091). The round tables gather representatives of the fleet, headquarters organizations and the technology community to identify and prioritize mid-term (7-15 years) to long-term (15-20 years) S&T requirements. For FY-95, the round tables corresponded to the 11 Joint Mission Areas and Support Areas (JMA/SAs) that the Navy and Marine Corps use for assessment and planning. (An additional round table addressed the topic of medical

requirements, which was not covered by a JMA/SA.) The output of the round tables, together with JMA/SA findings and direct fleet input via consolidated Command Technology Issues, form the basis of the STRG. Section II of this document, "Background," describes this process and its products in more detail.

Requirements vs. Technologies

The STRG focuses on requirements vice technology solutions. Toward this end, it was sometimes necessary to interpret round table results. For example, if the round table concluded that the Navy needs an improved shipboard defensive missile to defend against threat anti-ship missiles, then the STRG reports a requirement for improved capability in ship self-defense against cruise missiles. Possible solutions may include improved defensive missiles, guns, laser weapons, decoys, electronic warfare, etc. If such interpretation was not feasible, then the round table finding stands as it was written.

As specific technologies become widely available, they are accepted as foundations to build upon (e.g., infrared sensors, unmanned air vehicles). Technologists are free, of course, to consider alternative technologies with the same characteristics as established technologies. During the round tables, several technologies were mentioned repeatedly as possible solution paths; these are described later under the heading "Pervasive Technologies."

STRG Structure

Section II provides background for understanding the DoN S&T process, identifies the sources used to define requirements, explains the process used to assess priorities, and describes S&T budget categories.

Section III consists of 12 chapters that describe the domains of the JMA/SAs and their related round tables, and that explain the functions, issues and requirements discussed in S&T round tables and consolidated fleet Command Technology Issues (CTIs). CTIs, which describe fleet deficiencies amenable to solution through technology, represent direct fleet input to the research and development community. Functional descriptions outline what operators do (e.g., defend a platform, destroy specific targets or launch a ground attack) and, where appropriate, tell why operators cannot perform specific aspects of future missions. Each chapter contains a table of requirements describing what operators need to complete their missions or to carry them out more effectively. These details are intended to give technologists approximate values to work with, not to establish absolute mission requirements.

The last section is the Appendices which includes the abbreviated architecture for each of the 12 round tables plus the latest Program Review (PR97) S&T budget profile and a glossary.

Section II

Background

Planning Process

<u>JMA/SA Structure.</u> To improve assessment and planning, DoN established 11 Joint Mission Areas and Support Areas with the following domains:

JOINT MISSION AREAS	
Joint Strike Warfare	Application of tailored, offensive military force against fixed or mobile targets, complexes, or systems. Strikes coordinate joint assets and are supported by surveillance and C^4I.
Joint Littoral Warfare	Military operations conducted from coastal regions. Encompasses projection (or threat of projection) of forces inland . Prosecuted primarily through naval operations but may transition to sustained operations ashore. Domain extends from shore to open ocean and includes inland area that can be supported and influenced directly from the sea.
Joint Surveillance	Systematic observation and exploitation of the multidimensional battlespace by all available sensors.
Joint SEW / Intelligence	Destruction, control or neutralization of targets through integrated employment of command and control warfare and C^4I systems. Enhancement of battle management through integrated employment and exploitation of the electromagnetic spectrum and space. Intelligence includes collection, processing, integration, analysis, evaluation and interpretation of information about foreign countries or areas.
Strategic Deterrence	Use of political, economic and military capabilities to create a credible threat of unacceptable counteraction that causes an enemy to decide against specific actions. Creates a perception that cost exceeds gain and that actions hostile to U.S. interests would fail.

Maritime Support of
Land Forces

Surface, undersea and air dominance functions which enable rapid deployment and sustainment of U.S. combat forces. Includes functions, capabilities, platforms and systems necessary to establish and maintain superiority and to protect vital sea lines of communication, as well as the sealift capacity required to deploy and to sustain operations.

Forward Presence

Use of forward-based and forward-deployed naval forces to deter aggression, enhance regional stability, protect and promote U.S. interests, improve interoperability with allies and provide timely crisis response.

SUPPORT AREAS

Readiness

Navy and Marine Corps personnel and equipment that directly maintain and support the operations and training of naval forces.

Support and
Infrastructure

Activities, programs and personnel in acquisition support, environmental support, facilities, headquarters and commands, and information support that furnish resources to naval operating forces.

Manpower and
Personnel

Billet structure, manning level, and civilian/military mix of the shore and support establishment (including medical and reserve forces) necessary to provide essential support to active-duty and combat forces.

Training

Facilities, equipment, services, and instructors employed in accession training, specialized skill training, undergraduate flight training, and Navy and Marine Corps education programs to maintain readiness.

S&T Round Table Process. To improve the identification and prioritization of mid-term to long-term S&T requirements, DoN established the S&T round table process. This process consists of a series of annual meetings and subsequent briefings of results to flag-level sponsors. The subject-area structure of the round tables matches that of JMA/SAs to permit consistency and continuity between the processes for assessment and requirements determination. Each round table brings together knowledgeable, senior DoD civilians and military officers from the various warfighting and support communities. Participants provide practitioner-level information that is seldom heard at higher-level discussions. In addition to developing a prescribed set of products, round table participants meet to exchange views; identify operational goals and functions; identify key R&D requirements; develop community-level understanding of definitions, needs, functions, and S&T gaps; facilitate communication; build consensus; facilitate jointness; and focus the community's long-term S&T needs.

On a consensus basis, the participants at each initial round table meeting (called round table I) develop the following products:
- A description of the round table domain.
- A succinct strategic vision statement (top-level capabilities needed 7-20 years from now).
- A description of the future environment (threat, political, economic, technological, etc.).
- A list of goals and objectives to attain the vision.
- A prioritized list of required warfighting functions or capabilities.
- A functional architecture, or list of required capabilities with supporting elements.

The S&T round table process was inaugurated in FY-94. Its products serve as the baseline for the subsequent effort. This year, FY-94 round table I products were revisited and modified as necessary (including reprioritization of the warfighting functions). Noteworthy characteristics of the FY-95 S&T round table process are as follows:
- Round table domains matched those of the 11 FY-95 JMA/SAs, plus a round table to address medical requirements. This STRG presents the results of all 12 round tables.
- The round tables were coordinated and integrated with the JMA/SAs; assessments related to S&T were incorporated via participation of JMA/SA chairs and working group members at round table I meetings.
- Fleet input is enhanced by the timely availability of consolidated Command Technology Issues (CTIs), which are included in the STRG and are correlated to the prioritized S&T round table requirements in Section III. Nearly all the CTIs are addressed by round table results. The only exceptions are CTIs that do not involve long-range S&T investment but can be resolved by changes in tactics or policy, negotiations with foreign governments, or procurement of existing or near-term systems.

The round table polling procedure used to prioritize the warfighting functions is from an investment viewpoint. While all identified functions are important to attaining the goals and objectives, some represent persistent issues. They require a greater proportion of S&T investment to be successfully addressed in the long term. Prioritization is displayed in terms of Quartile rankings; namely, those which fall into the (approximately) top 25 percent in investment priority are said to be in Quartile I, etc.

Following the round table I series, results are briefed to sponsoring flag officers for review, modification and validation. Validated goals and objectives and prioritized warfighting functions represent a prioritized set of S&T requirements to be used as a guide for naval S&T investment. These serve as the principal input for STRG Section III, "Requirements."

round table II, which includes the Chief of Naval Research's (CNR) response to the requirements identified in round table I, generates notional S&T investment options.

Assessment Process. As the round table process matures, it should become increasingly comprehensive. In its first two cycles, it experienced a limitation related to the consensus-panel approach: emerging requirements tended to be underplayed or unreported. In subsequent round tables, participants will be encouraged to examine this important facet of requirements setting.

While the STRG stresses long-term requirements, it also includes some particularly significant short-term requirements that relate to long-term warfighting needs which are not being addressed. All issues and requirements in the STRG have been reviewed by OPNAV sponsors.

Other Documents and Processes. The STRG contains enough background information and specifics to convey the essence of S&T requirements. It neither replaces Operational Requirements (ORs) nor eliminates the need to determine all the requirements for specific systems (including requirements that are not technology limited). Two other documents, Technology Base Guidance (TBG) and Advanced Technology Demonstration Guidance (ATDG), derive from the STRG. The TBG guides investment in 6.1 and 6.2 while the ATDG guides investment in 6.3.

The time frames of the various processes differ but requirements development is a closed-loop process. Requirements are published yearly and forwarded to the organizations that develop advanced technology. They investigate and refine technology until it is ready to use in a system. Ordinarily, a technology moves through the acquisition funding process from 6.1 through 6.2 to 6.3 before becoming available for use in an acquisition program. This usually takes several years. Occasionally, a technology is sufficiently mature after a 6.2 effort to move directly into system development. The Systems Commands (SYSCOMs) match available technology with Mission Needs Statements to upgrade existing systems or to develop new ones. This process also can be lengthy. The objective is for a new or improved capability to reach the fleet. As the fleet uses a system, it modifies operational requirements, generally demonstrating that some needs have been satisfied. This also may take a few years but the roles and missions of the fleet can change quickly in response to domestic and international politics. Such changes feed into the S&T round table process and then into the STRG. Other feedback loops generate requirements which are directly reflected in the STRG as an interim item to be exercised in the next round table series. Still others occur as opportunities generated by technological breakthroughs that allow forward thinkers to envision entirely new methods of accomplishing naval objectives. These ideas often come not from the warfighters but from the technology community, which enjoys some detachment from the immediate problems that beset the fleet.

S&T Environment

Overarching Considerations. The Defense Planning Guidance provides general background on anticipated threats and defense strategy that drive current S&T requirements. While each strategy in the Defense Planning Guidance is important in itself, several considerations are key to making any of them work and must be satisfied by any new weapon system or process for the fleet. Overarching requirements that emerged during round tables and CTIs are as follows:
- Readiness--Ability to move out to a regional conflict.
- Sustainability and support--Ability to maintain two simultaneous regional conflicts.
- Essential force capability--Sufficient weapons and personnel for deterrence.
- Robust S&T program focused on operational need--Ability to stay ahead of potential threats.
- Reduced rate of acquisition--Need to slow expenditures, absent an arms race.
- Reduced overhead and infrastructure--Need for fewer people, smaller support structure.

In addition to identifying overarching *requirements*, the round tables and CTIs identified overarching *values* important to all S&T and which must be considered in evaluating ongoing and proposed efforts:

- Affordability: Is it cost effective in the long run? Do we have the money today to make this investment for the future?
- Crisis Response: Will the resulting systems be readily available and reliable? Can we train people to use them without long preparation?
- Technology Transition: How fast can it transition into a useful military system?
- Sustainability: Is the technology robust? What logistics structure will it require?

S&T Investment Strategy. To make best use of S&T resources, we must maintain a strong S&T program focused on meeting future fleet requirements and on avoiding technological surprise. Geopolitical uncertainty requires us to emphasize regional warfare while maintaining a balanced S&T program. Worldwide proliferation of technology requires us to work harder to maintain a lead in core warfighting competencies.

Technology needs further maturing through demonstrations and prototyping, through field test and evaluation in the R&D phase, and through operator input. We must evaluate technology not only for military effectiveness but also for flexibility, cost reduction, long-term payoff, and dual use. *Flexibility* will allow platforms and weapons to perform several types of missions. *Cost reduction* will reduce manloading, embed training within the system, and produce equipment with greater reliability, maintainability and availability. *Long-term payoff* may mean that a small change now yields greater cost reduction or fewer lost lives in the future. *Dual use* will allow industry and the military to share the benefits of technological advances, thus better leveraging our investment of tax dollars.

We expect technology to produce fundamental changes in how warfare is conducted--perhaps by sending fewer people into battle, or by using weapons that stop enemy forces without killing them, or even by deterring aggression before it starts. The technology community will help foster such change.

Defense Science and Technology Strategy.

The DoN FY95 S&T round table process, the basis of the STRG, preceded the publication of the September 1994 Defense Science and Technology Strategy. For reference, a summary of the Defense Science and Technology Strategy is provided below:

I. Vision - Develop and transition superior technology to enable affordable, decisive military capability and to enhance economic security.

II. S&T contribution to Military Capability Needs. The five future Joint Warfighting Capabilities are: (1) To Maintain near perfect real-time; (2) To engage regional forces promptly in decisive combat, on a global basis; (3) To employ a range of capabilities more suitable to actions at the lower end of the full range of military operations which allow achievement of military objectives with minimum casualties and collateral damage; (4) To control the use of

space; and (5) To counter the threat of weapons of mass destruction and future ballistic and cruise missiles to the CONUS and deployed forces.

III. Strategic Investment Priorities. The generic priorities are *Dual Use* and *Affordability*. The Technology priorities are: (1) Information Science and Technology; (2) Modeling and Simulation; and (3) Sensors.

IV. Guiding Principles for Science and Technology Management. The five management principles are: (1) Transition Technology to Address Warfighting Needs; (2) Reduce Costs; (3) Strengthen the Commercial-Military Industrial Base; (4) Promote Basic Research; and (4) Assure Quality.

Budget Categories

The Science and Technology program consists of efforts in three budget categories:

<u>Basic Research (6.1)</u>--Exploration of physical properties and characteristics to determine which may have military applications. Basic research typically targets improvements that may be realized 10 to 20 years in the future. Occasional breakthroughs have immediate application. Work in this category carries the highest risk of technological failure.

<u>Exploratory Development (6.2)</u>--Examination of the output of basic research and application of this knowledge to evaluate enhanced military effectiveness, reduced cost, etc. (also called applied research). Exploratory Development determines if a technology can be effective in a real system. Results sometimes are brought directly into the engineering and manufacturing development stage of the acquisition cycle but usually the technology needs to be matured (as a subsystem) through advanced technology demonstration. Risk is relatively high but lower than that of basic research.

<u>Advanced Development (6.3)</u>--Places Exploratory Development results into prototype working systems to reduce technology risks associated with integration. Includes both Advanced Technology Demonstrations (ATDs) and core programs. Although risk generally is lower than that of the other S&T categories, the risk of ATDs is still much higher than is tolerated in Engineering and Manufacturing Development. Core programs aligned with major warfare areas facilitate transition of Exploratory Development to system acquisition on a continuing basis.

Appendix 13, page 271, provides a budget profile for all program elements within the S&T budget categories.

Section III

Specific Requirements

Contents

This section presents prioritized Science and Technology (S&T) requirements in categories aligned with the 11 FY-95 Joint Mission Areas / Support Areas (JMA/SAs) plus a separate chapter for medical technology. The requirements primarily reflect the findings of the FY-95 round table process but also include pertinent input from JMA/SA assessments and consolidated fleet Command Technology Issues (CTIs). The subjects of the chapters are as follows:

Chapter 1:   Joint Strike Warfare
Chapter 2:   Joint Littoral Warfare
Chapter 3:   Joint Surveillance
Chapter 4:   Joint Space and Electronic Warfare / Intelligence
Chapter 5:   Strategic Deterrence
Chapter 6:   Maritime Support of Land Forces
Chapter 7:   Forward Presence
Chapter 8:   Readiness
Chapter 9:   Support and Infrastructure
Chapter 10:   Manpower and Personnel
Chapter 11:   Training
Chapter 12:   Medical

Format and Nomenclature

Consistent with the outline of S&T round table I products (described in Section II), each chapter contains (1) a strategic vision statement, (2) a description of the category's definition and scope, (3) a functional description of the category, (4) a list of prioritized top-level warfighting functions (functional architecture), and (5) a list of S&T requirements showing relative priorities and CTI correlation. An appendix corresponding to each chapter contains the prioritized functional architecture and (where appropriate) verbatim CTI input.

As noted in Section II, each round table produced (1) goals and objectives leading to realization of the strategic vision and (2) succinctly worded functions necessary to achieve the goals and objectives. The functions were prioritized via an investment polling method. In some cases

(e.g., Forward Presence), the wording of the goals and objectives matched that of the functions so no mapping or correlation was necessary. In other cases, the wording of goals and objectives and of functions was sufficiently dissimilar to require considerable effort to map one to the other.

The goals and objectives are more descriptive than the list of functions. They appear in Section III chapters as Prioritized S&T Requirements. Priority is indicated by a Roman numeral (I = high, IV = low) under the column heading "Quartile." Pertinent CTIs are mapped to prioritized requirements and are identified by an alphanumeric under the column heading "CTI." Identification of mid- and far-term requirements is included where feasible.

Requirements identified in the round tables tend to be more comprehensive and more generally worded than those identified in CTIs. Accordingly, to map CTIs to round table results, it sometimes was necessary to infer that meeting a round table requirement would also address the CTI requirement.

Chapter 1

Joint Strike Warfare

Strategic vision: Affordable systems that achieve the desired level of damage on targets while minimizing losses of own forces under all environments at any time.

Definition and Scope

Joint Strike, as defined for the Joint Mission Area/Support Area assessment, is the application of tailored, offensive military force against fixed or mobile targets, complexes, or systems to achieve specified goals. Strikes may be either single or multiple strikes in support of a campaign through coordination of joint assets and seamless information flow.

For the S&T round table, this technology area was divided into two panels addressing its major components: sensors and weapons/platforms.

Sensors include physical, electromagnetic and acoustic devices as well as the electronics, optics, mechanical devices, data links, and signal processors which convert received energy into information. Sensors may be active or passive. Active sensors include the electronics to send a signal as well as receive it. Sensors used for Joint Strike will support precise, offensive military force against fixed or mobile targets.

Weapons and platforms include all missiles, bombs and other weapons used for self defense or precision strike; and all aircraft, submarines, surface ships and unmanned vehicles that support Joint Strike. Weapons and platforms apply precise, offensive military force against fixed or mobile targets.

Functional Description

Joint Strike Warfare encompasses all actions from prehostility planning through war termination, including the following steps:
- Ensure cooperative and complementary interaction among long-range bombers, tactical air (TACAIR), cruise and other missiles, and USMC/USA/allied ground forces ashore throughout the operation.

- Arrive by sea and manage ship and aircraft signatures either to inflate apparent strength or to achieve tactical surprise.
- Assess opposing capability in real time with on-scene C^4I adaptation, as needed.
- Rehearse missions using sophisticated simulation tools linked together in real time.
- Disarm adversary strike capability by conducting precision strikes on highest priority targets.
- Undermine opponents' incentive to fight by demonstrating the capability to deliver precision and other strike weapons.
- Avert unnecessary restrikes through timely, accurate battle-damage assessment (BDA).

Sensors gather information about the environment, targets, aim points and battle damage. They transmit and receive information via data links. Information is either processed autonomously or through a human interpreter. To maintain survivability of personnel and platforms, sensors with longer-range and precision-location capability of fixed, mobile and concealed targets is required.

Weapons and platforms are deployed in four phases to support joint strike warfare. Phases can be executed sequentially or simultaneously as required by the battlefield commander. The first phase must halt the invasion. This is accomplished by assisting in the initial defense and achieving air superiority. Precision strikes may be conducted to destroy high-value targets with the aim of substantially reducing the enemy's desire to wage war. Phase two allows the build-up of U.S. power while consistently reducing the enemy's ability to conduct war. Strikes are conducted against enemy offenses and battlefields. Phase three supports the ground counter-offensive. It involves sustained battlefield engagement leading to decisive defeat of the enemy. Phase four provides for post-conflict stability by retaining a versatile strike capability in theater.

S&T Requirements

Underlying the strategic vision for Joint Strike Warfare are 10 top-level warfighting functions, prioritized as follows:

1. **PRECISION ATTACK.**
2. **TARGETING/FIRE CONTROL.**
3. **AIR SUPERIORITY.**
4. **STRIKE PLATFORMS AND WEAPONS (AIRFRAME & PROPULSION).**
5. **SURVIVABILITY (PLATFORMS & WEAPONS).**
6. **JOINT STRIKE MANAGEMENT.**
7. **SURVEILLANCE AND RECONNAISSANCE.**
8. **TACTICAL CONNECTIVITY.**
9. **BOMB DAMAGE ASSESSMENT.**
10. **SHIPS/SUBMARINE PLATFORMS (RELATED SYSTEMS).**

Table 1 lists prioritized goals and objectives under each of the 10 top-level warfighting functions. These goals and objectives represent S&T requirements for Joint Strike Warfare. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues

(CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Joint Strike-related paragraphs in the CTIs, published verbatim in Appendix 1. For reference, Appendix 1 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 1. JOINT STRIKE WARFARE: PRIORITIZED S&T REQUIREMENTS

1. PRECISION ATTACK	Quartile	CTI
a. Develop improved data links to enhance weapon effectiveness--i.e., with the following attributes: (1) Unconstrained operations. (2) Over-the-horizon (OTH) capability. (3) Interoperability. (4) Low probability of intercept (LPI). (5) Anti-jam. (6) Secure. (7) Enabling third-party weapons control (incl. man-in-the-loop). (8) Improved human factors. (9) Low observable (LO) compatibility.	I	1-A
b. Provide improved weapon seeker capabilities which: (1) Provide autonomous target recognition capability. (2) Detect, acquire and track at longer ranges. (3) Increase capability in adverse weather. (4) Increase capability in high natural and man-made clutter. (5) Enable aim point selection in autonomous terminal guidance. (6) Reduce information required from launch platform both before and after launch.	I	1-C
c. Develop weapon system capability to assess terminal situation and avoid collateral damage.	I	1-C
d. Improve weapons lethality. (1) Improve single-shot probability of kill (P_k) of all weapons. (2) Increase penetration by 50 percent over Bomb Live Unit (BLU)-109. (3) Develop capability for multiple kills per weapon versus massed tactical vehicles beyond BLU-108.	I	1-C
e. (Mid-, far-term) Develop targeting, weapons kinematics, and weapon control to stand outside 10-20-year threat envelope.	I	1-C

f. Develop improved capability to attack mobile theater ballistic missile (TBM) launcher and time-critical fixed sites.   I

g. (Mid-term) Develop sensor suite that reduces fratricide without limiting weapon use.   I   1-B
   (1) Provide accurate ID of all elements in area of regard at range commensurate with ability to redirect current/near-term weapons.

h. (Far-term) Provide same capabilities for future platforms, weapons and sensors or for later iterations of current systems.   I   1-B

i. Provide weapon/platform interface capability to ensure: II
   (1) Reduced platform sources of data latency and incompatibility.
   (2) Communication with any weapon that can be carried.
   (3) Prosecution of fixed, relocatable and mobile targets in real time.
   (4) Hand-off of accurate data for prosecution.
   (5) Positive ID of prospective targets as friendly/neutral/hostile.
   (6) Use of available platform/weapon sensors with data link assets to provide real-time battle damage information (BDI).

j. Provide capability to use weapons at will with minimal effect on man-made and natural environments.   II

k. Develop weapons that operate against both land and sea targets.   II   1-C

l. (Mid-term) Integrate sensor suite with current and near-term platforms and weapons in order to: II
   (1) Minimize constraints on maneuvers and tactics.
   (2) Have a field of regard that complements kinematic capabilities.
   (3) Detect and identify all targets in area of uncertainty (based on weapon range, navigation accuracy and targeting accuracy).
   (4) Confirm presence of intended target(s) in terminal areas; if unable to confirm, support retargeting.
   (5) Permit their employment without regard for weather, time of day, or passive/active countermeasures.

m. (Mid-, far-term) Improve the capability of current and future naval   **III**
weapon systems for the suppression of enemy air defenses (SEAD).
>   (1) Develop alternate targeting capability for anti-radiation missile
>   (ARM) to counter threat shutdown.
>   (2) Develop weapon system for preemptive strike vs. integrated air
>   defense systems (IADS).
>   (3) Develop improved ARM antenna, sensors for 100% direction of
>   arrival accuracy improvement.
>   (4) Define capabilities and parameters to isolate IADS emitters.

n. (Mid-term) Develop sensor suite to support remote control of   **III**   **1-B**
weapons via data link and provide BDI/BDA capability to:
>   (1) Support weapon control at standoff range from enemy defenses.
>   (2) Provide BDI/BDA of quality sufficient to allow operators and strike
>   managers to optimally allocate strike assets.

2. TARGETING/FIRE CONTROL	Quartile	CTI
a. Provide launch platforms with a targeting and fire control capability for joint and combined operations.	**I**	**1-B**

>   (1) (Mid-term) Provide data links with the following attributes:
>   (a) Unconstrained operations.
>   (b) OTH capability.
>   (c) Interoperability.
>   (d) Low Probability of Intercept (LPI).
>   (e) Anti-jam.
>   (f) Secure.
>   (g) Enabling 3rd-party weapons control (incl. man-in-loop).
>   (2) (Mid-term) Provide a seamless platform/weapon interface.
>   (a) Develop platform and weapon technologies to allow platforms to
>   carry current weapons/stores without compromising signature.
>   (b) Develop platform capability to fuse, correlate and translate all
>   sensor data for weapon hand-off.
>   (3) (Mid-term) Develop advanced capability for automated platform-
>   based target classification/identification.
>   (4) (Mid-term) Provide capability for producing fire-control-quality
>   targeting information outside the threat envelop that fully exploits the
>   weapon's capability.
>   (5) (Mid-term) Develop a sensor-to-shooter targeting capability.
>   (6) (Far-term) Provide a seamless platform/weapon interface.
>   (a) Develop platform and weapon technologies to allow platforms to
>   carry future weapons/stores without compromising signature.

(7) (Far-term) Provide platform targeting capability that does not increase the platform signature. (Includes passive targeting sensors and multisensor/platform cooperative techniques.)

(8) (Far-term) Provide real-time sensor-to-shooter targeting ability.

b. (Mid-, far-term) Suite of sensors to provide high confidence level indications of enemy presence, composition, and intentions.   II   1-B

(1) Timeliness of information must support weapons employment beyond enemy weapons capability.

c. Improved sensor accuracy to ensure: II

(1) (Mid-term) Improved first-pass single-target kill (P_k) of 0.8 with minimum weapons.

(2) (Far-term) Improved first-pass multiple-target kill (P_k) of 0.8 with minimum weapons.

(2) (Mid-term) Improved bombing cicular error of probability (CEP) to ≤ 10 feet.

(3) (Mid-term) Sensor performance shall not be limiting factor in defining weapon release parameters.

d. (Mid-, far-term) Develop a sensor suite that reduces fratricide without limiting weapon use by providing accurate ID of friendly, hostile and neutral elements in area of regard.   II   1-B

(1) Provide ID beyond employment range of air launch weapons.

e. Develop suite of sensors that supports targeting requirements: III   1-B

(1) (Mid-term) Provide multi-spectral processing, correlation and display to operator.

(2) (Far-term) Provide multi-spectral processing, correlation and display to operator in three dimensions.

(3) (Mid-term) False alarm rate will account for < 10% of expenditures of weapons without fratricide.

(4) (Far-term) Reduce false-alarm and fratricide rates to zero.

(5) (Mid-term) Sensors provide targeting information commensurate with existing and near-term weapon capabilities.

f. The sensor suite shall provide sufficient resolution to: III   1-B

(1) (Mid-term) Allow target characteristic measurement accuracy for cruise missile mission planning that is 50% better than now available.

(2) (Mid-, far-term) Increase target discrimination to allow target ID beyond range of air launch weapon employment.

g. (Mid-, far-term) Develop a suite of sensors that provides timely **III**
information for all phases of a campaign for all tactical situations.
(1) Reduce cruise missile response time.

h. (Mid-, far-term) Develop sensor suite allowing near-term weapons **III**
employment:
(1) Without regard for weather or time of day.
(2) Without regard to passive or active countermeasures.

i. Suite of sensors to provide autonomous acquisition and prosecution of **IV**
time-critical targets in open and cluttered environments:
(1) (Mid-term) With minimal information beyond area and target type.
(2) (Far-term) With prior information limited to general target area.

j. (Mid-, far-term) Integrate sensor suites with weapons and platforms **IV**
to allow man-in-the-loop and autonomous operation at full capacity of
weapon and platform.

3. AIR SUPERIORITY	Quartile	CTI
a. (Mid-term) Develop new missile systems that out-perform all current and projected threat air-to-air missiles and systems.	I	1-C

(1) Achieve greater E-Pole and A-Pole distances than existing and
projected future threat missiles.
(2) Design new missiles with greater maneuverability (high angle of
attack/agility/turn performance) to perform at the high end (limits of
basic airframe) of platforms during launch and throughout all altitude
regimes (missile off rail to end game).
(3) Design missile propulsion motors that out-perform current
technologies (speed, acceleration/boost-glide, g-sustainability).

b. (Mid-term) Develop tactical air superiority weapons that have a **II** **1-C**
multimission capability that provide high P_k against air, surface or
ship targets.
(1) Develop accuracy to allow first-pass target kill of 0.8 P_k with
minimum number of weapons.
(2) Develop platform-weapon ID capability for friend/foe.
(3) Improve air-to-air standoff kill capability.
(4) Investigate alternative weapon systems (e.g., directed energy).

c. (Mid-term) Provide ability to achieve air-to-air superiority (engage,   **II**
  destroy, influence enemy so as to deny tactical use of the airspace)
  under all environmental conditions.
  (1) Enhance existing weapons' / develop future weapons' ability to detect,
     acquire, track, engage and destroy threat platforms in:
     (a) Clutter (natural environment).
     (b) Countermeasures (electronic, multispectrum, decoys, lasers).

d. (Mid-term) Design data link systems with service commonality so all   **II**   **1-A**
  platforms/weapons can communicate two-way with each other,
  providing indications and warnings (I&W) and common tactical
  picture to all users.
  (1) Provide:
     (a) Secure (non-exploitable) links (selectable).
     (b) Anti-jam capability (selectable).
     (c) Low probability of intercept/exploitation (LPI/LPE) voice and
        data channels.
     (d) Real-time data flow.
     (e) Tailorable information presentation by receiver.
  (2) Provide the capability to support weapon control at standoff range
     from enemy defenses.
  (3) Provide BDI/BDA of quality sufficient to allow operators and strike
     managers to optimally determine results.

e. (Mid-term)   Integrate all sensor/weapons input, giving ability to   **II**   **1-B**
  detect/engage threats in all quadrants.
  (1) Provide a positive ID on all air contacts beyond employment range of
     threat and own air-launched weapons.
  (2) Ensure correlation of off-board sensors for I&W cueing to allow man-
     in-loop and autonomous operation at full capability against all classes
     of targets in all environments.
  (3) Ensure real-time assimilation of data and communications with
     employed weapons.
  (4) Develop signature control to meet operational/aerodynamic
     requirements.
  (5) Improve platform/weapons integration to allow improved first-pass
     target kill (P_k) of 0.8 with minimum weapons.
     (a) Improve missile seeker and target detection device (TDD)
        sensitivity versus all classes of targets in all environments.

**f. (Mid-term) Develop missile seeker systems that outperform all   II   1-C
    current and projected missile suites.**
    (1) Improve missile seeker systems' counter countermeasure (CCM) suite.
    (2) Build-in LO characteristics to thwart detection.
    (3) Design seeker head agility to enable high-off-boresight launch and
        track capability.
    (4) Improve detection/acquisition/track capability in range and in high
        clutter environments.
    (5) Develop ability to achieve threat/friendly positive ID through multiple
        means.
    (6) Ensure that weapons seekers have a field of regard that complements
        missile kinematics and platform sensor packages.

**g. (Mid-term) Continue development of most capable weapons systems   II
    emphasizing miniaturization--size, weight, signature (carriage and
    launch)--while improving kinematics, warhead and platform
    interface.**

h. (Mid-term) Improve stand-off weapon engagement capability.   II   1-C

i. (Mid-term) Improve situational awareness.   II   1-A
    (1) Provide technology to furnish near-real-time updates at appropriate
        levels (automatically determined) to tactical users (battlegroup, ship,
        sub, aircraft, tank and platoon).
    (2) Provide a common tactical picture.
        (a) Tailored, real time (only essential data).
        (b) Configurable by the user (prioritization).
        (c) Geopositioned, anti-jam, secure.
        (d) Voice/data, redundant for critical items.
        (e) Two way.
        (f) Positive ID of friend (near), foe (far).

j. Improve counter-air capability.   II   1-B,
    (1) (Mid-term) Improve active and passive acquisition and tracking   **1-C**
        capability of fighter and airborne early warning (AEW) aircraft
        against all classes of targets in all environments.
    (2) (Mid-term) Improve missile seeker and TDD sensitivity versus all
        classes of targets in all environments.
    (3) (Mid-term) Provide platform/weapon ID capability for friend.
    (4) (Far-term) Provide ID capability for foe (non-cooperative).
    (5) (Mid-term) Provide high-off-boresight target detection, acquisition,
        and tracking.

k. (Mid-term) Develop weapons payloads (warhead-fusing) to increase   **III**   **1-C**
effectiveness against threat platforms such as unmanned airborne
vehicles (UAVs), theater ballistic missiles (TBMs), cruise missiles,
manned aircraft and their defensive measures (LO, electronic
countermeasures (ECM), decoys) in or near clutter.
(1) Develop a weapon with near-100 percent P_k (1 weapon, 1 kill).
(2) Design a system that will not be countered by defensive electronic
    counter measures, decoys or concealment techniques.
(3) Ensure that the warhead-fuse system has the ability to detect, fuse and
    destroy targets employing LO.

l. (Far-term) Provide same capabilities for future platforms, weapons   **III**   **1-C**
and sensors or for later iterations of current systems.

m. Improve suppression of enemy air defense (SEAD) capability.   **III**   **1-B**
(1) (Mid-term) Develop capability to preemptively destroy radars that
    transmit long enough for geolocation, then do not emit again.
(2) (Mid-term) Provide affordable and effective sensors to allow
    targeting, decoying, deceiving and confusing enemy air defenses
    including newer technology threats.
(3) (Mid-term) Develop passive ranging capability.
(4) (Mid-term) Provide ID capability for friend (redundant, no false
    positive)
(5) (Far-term) Provide ID capability (non-cooperative) for foe.
(6) (Mid-term) Provide reliable standoff soft kill for all emitters,
    including command and control capability.

4. STRIKE PLATFORMS AND WEAPONS (AIRFRAME & PROPULSION)	Quartile	CTI
a. Produce technology allowing strike assets to manage their signatures to delay detection and targeting from threat sensors.	I	1-C

(1) (Mid-term) Reduce signature of planned designs by 40% and 50%
    (inventory weapons) to improve survivability against RF and IR
    sensors.
(2) (Far-term) Reduce the designed signature of follow-on systems to
    reduce acquisition range by 50% (over existing and planned
    airframes) and 80% (weapons) to provide survivability against RF, IR,
    electro-optic (EO), UV and acoustic threat sensors.

b. Develop an integrated sensor/weapons/countermeasure system which   I   1-C
reduces susceptibility of strike assets to tracking/targeting.
    (1) (Mid-term) Develop a system integrating existing weapon system,
        sensors and countermeasures on strike assets, allowing unrestricted
        sensor operation while denying threat tracking and targeting by 4th-
        generation air and ground defense systems.
    (2) (Far-term) Enable follow-on aircraft to use sensors and
        countermeasures in concert with signature management.

c. Develop technology to alleviate constraints of tanking on carrier-   I
based aircraft.
    (1) (Mid-term) Investigate alternative methods of extending the range
        and endurance of sea-based aviation.
    (2) (Far-term) Develop alternative fuels with higher specific energy.

d. Develop technologies which capitalize on new materials and   I
structures in airframe design.
    (1) (Mid-term) Through innovative design, achieve a 40% savings in
        aircraft weight and cost.
    (2) (Mid-term) Integrate new materials and designs to reduce signature.
    (3) (Far-term) Design with commonality for compatibility, support and
        economy, yielding 50% cost savings.

e. Provide an aerodynamic design which optimizes multi-role   I
performance in future naval aircraft which will exceed existing or
postulated adversary performance.
    (1) (Mid-term) In carrier-suitable, multi-role aircraft, provide short-
        period agility (aircraft pointing) capability for air superiority.
    (2) (Mid-term) In carrier-suitable, multi-role aircraft, provide stable
        bombing system for accurate release of air-to-ground ordnance.
    (3) (Far-term) Develop technology which allows high performance 5th-
        generation aircraft to operate off naval ships without penalizing
        performance or survivability features.

f. Continue to develop higher performance engines which can operate in   I
the naval environment.

g. Reduce vulnerability of strike assets to single-hit kill.   II   1-D
    (1) (Mid-term) Provide aircraft the capability to overcome single,
        potentially catastrophic subsystem failure (electric, hydraulic or fuel)
        and return to safe area for recovery or ejection.
    (2) (Far-term) Provide follow-on aircraft the ability to overcome
        catastrophic main subsystem failure (electric, hydraulic, control
        surfaces, fuel, etc.) and continue the assigned mission.

h. Provide usable situational awareness to the tactical decision maker.   III   1-A
    (1) (Mid-term) Develop technology to furnish near-real-time updates to tactical data users.
    (2) (Mid-term) Provide a common tactical picture (tailored, real-time, configurable by user) which is accessed by all operators.
    (3) (Far-term) Provide information management and decision aiding of all tactical information to the operator.

i. (Mid-term) Provide a cockpit environment in which the air crew may   III   1-D
function at optimum performance.
    (1) Provide capability for air crew to function in high acceleration.
    (2) Provide environment in which air crew can function in hostile conditions of directed-energy, chemical/biological/radiation hazards.

j. (Mid-term) Provide safe means of escape for air crew in all flight   III   1-D
regimes.
    (1) Provide ejection system covering entire operational envelope.

5. SURVIVABILITY (PLATFORMS AND WEAPONS)	Quartile	CTI
a. (Mid-term) Develop surveillance and targeting sensors that do not jeopardize survivability.	I	1-B
(1) Execute covert operations with low probability of intercept.		
(2) Manage signature to become undetectable from host.		
b. (Mid-term) Develop sensors that increase survivability.	I	1-B
(1) Detect threats outside of tactical engagement envelope		
(2) Fuse and Correlate all sensor types		
(3) Provide real-time awareness to the user		
(4) Deter Threat (self-protection systems)		
c. (Far-term) Develop sensors that provide survivability.	I	
(1) Disable threat.		

6. JOINT STRIKE MANAGEMENT	Quartile	CTI
a. (Mid-term) Provide real-time strike management capability for joint/combined operations.	I	

    (1) Provide planning information that is:
        (a) Automated
        (b) Measure-of-effectiveness-driven
        (c) Deconflicted for multiple sources
        (d) Situationally constrained
        (e) Predictable in outcome or confident of success
        (f) Capable of assessing and exploiting threat levels.
        (g) Capable of using real-time weather information

(2) Provide targeting information for:
    (a) Automated nomination of critical modes
    (b) Near-real-time targets
    (c) Unconventional target signatures

(3) Provide weaponeering information that is:
    (a) Computer-aided
    (b) Measure-of-effectiveness-driven
    (c) Situationally constrained
    (d) Human/review friendly
    (e) Formatted to weapon systems

(4) Develop systems that provide initial capability for:
    (a) Interactive dissemination with low data rate/video/imagery capability
    (b) Validation
    (c) Automated data

(5) Provide initial rehearsal capability that has:
    (a) Low data rate/video/imagery exchange
    (b) Automation
    (c) Contingency operation
    (d) Validation
    (e) Individual/force levels available
    (f) Simulation

(6) Aid the user during execution and provide information that is:
    (a) Near-real-time and incorporates tactical picture, force status and control, ROE and tasking
    (b) Computer-aided
    (c) Common and compatible
    (d) Uninterruptable

(7) Develop reporting sensors and support systems that enhance:
    (a) Timeliness
    (b) Accuracy
    (c) Automation
    (d) Sanitization
    (e) Low data rate compatibility
    (f) Visual presentation

b. (Far-term) Full capability for issues raised in mid-term requirements.   **I**

7. SURVEILLANCE AND RECONNAISSANCE	Quartile	CTI
a. Improve sensor efficiency.	I	**1-A, 1-C**
(1) (Mid-term) Improve module efficiency by 25%.(Measure of Effectiveness: output/power required)		
(2) (Far-term) Improve module efficiency by 50%.		
(3) (Mid-term) Reduce sensor size and weight by 35%.		
(4) (Far-term) Reduce sensor size and weight by 75%.		
(5) (Mid-term) Improve performance in clutter by 35%. (measure of effectiveness (MOE): signal-clutter ratio)		
(6) (Far-term) Improve performance in clutter by 100%.		
b. Improve signal and data processing.	I	**1-A, 1-C**
(1) (Mid-term) Increase throughput by 300% to allow for shared aperture, multi-mission. (MOE: data bit/sec improvement)		
(2) (Far-term) Increase throughput by 1000% to allow for shared aperture, multi-mission.		
(2) (Mid-term) Improve multi-sensor data integration / fusion.		
(4) (Far-term) Timely integration and dissemination of all source sensor data in an accessible database with minimum redundancy / ambiguity - 95%. (MOE: confidence factor.)		
c. Positive location and ID of friendly, neutral & threat units.	II	**1-B**
(1) (Mid-term) Provide location data over theater of operations with 3-sq.-mile accuracy at all times.		
(2) (Far-term) Provide location data over theater of operations with 0.5-sq.-mile accuracy at all times.		
(3) (Mid-term) Continuous positive location and ID of friendly forces; confidence factor of 95%.		
(4) (Far-term) Continuous positive location and ID of friendly forces; confidence factor of 99%.		
(5) (Mid-term) Location and ID of all neutrals; confidence factor of 80%. (MOE: Confidence factor)		
(6) (Far-term) Location and ID of all neutrals; confidence factor of 95%. (MOE: Confidence factor)		
(7) (Mid-term) Location and ID of hostiles; confidence factor of 80%. (MOE: Confidence factor)		
(8) (Far-term) Location and ID of hostiles; confidence factor of 99%. (MOE: Confidence factor)		
(9) (Mid-term) Timely (20 min.) location/ID of time-critical threats to ensure targeting prior to employment.		
(10) (Far-term) Timely (5 min.) location/ID of time-critical threats to ensure targeting prior to employment.		

(11) (Mid-term) Reduce the incidence of false targets within the surveillance database to 10%. (MOE: false/total targets ratio)

(12) (Far-term) Reduce the incidence of false targets within the surveillance database to 1%.

d. (Mid-term) Joint/common tactical picture: **II**   **1-A**

(1) Provide joint access to organic/non-organic sensor data through a common database. (MOE: reduction of data link nets)

(2) Timely integration and dissemination of all source sensor data in an accessible database with minimum redundancy / ambiguity - 85%. (MOE: confidence factor)

(3) Presentation of data to the user in threat priority.

e. Sensor integration/function compatible with LO/very low observable   **II**
(VLO) characteristics

(1) (Mid-term) Surveillance, reconn and combat identification/positive identification (CID/PID) functionality in LPI modes - 50%. (MOE: integration into platforms)

(2) (Far-term) Surveillance, reconn and (CID)/(PID) functionality in LPI modes - 90%. (MOE: integration into platforms)

f. All-environment sensor capability: **III**

(1) (Mid-term) Provide night, all weather sensors that are highly resistant to countermeasures and battle effects - 90%.(MOE: sensor data availability)

(2) (Far-term) Provide night, all weather sensors that are highly resistant to countermeasures and battle effects - 99%.(MOE: sensor data availability)

g. Expand sensor area of coverage.   **III**   **1-B,**
                                                                                           1-C

    (1) (Mid-term) Provide continuous detection and location of major units and prime targets of interest over the entire theater of operation ($<150,000$ km^2 area). (Major threats include troop concentrations, artillery and logistic support; prime threats include TBM armored vehicles, aviation and mobile defenses, power plants, oil refineries, weapons production facilities, etc.)

    (2) (Far-term) Provide continuous detection and location of major units and prime targets of interest over the entire theater of operation ($150,000+$ km^2 area). (Major threats include troop concentrations, artillery and logistic support; prime threats include TBM armored vehicles, aviation and mobile defenses, power plants, oil refineries, weapons production facilities, etc.)

    (3) (Mid-term) Provide continuous location and tracking of tactical combat units, supporting units and defenses in/around the battle area ($50,000$ km^2 area). (Tactical combat units are at platoon level, supporting units include direct support aviation.)

    (4) (Far-term) Provide continuous location and tracking of tactical combat units, supporting units and defenses in/around the battle area ($100,000$ km^2 area). (Tactical combat units are at platoon level, supporting units include direct support aviation.)

h. Provide responsive and sustained surveillance.   **III**   **1-B**

    (1) (Mid-, far-term) Begin coverage of the area defined in the above objective within 4 days.

    (2) (Mid-term) Sustain surveillance of above objective for 30 days.

    (3) (Far-term) Sustain surveillance of above objective for 90 days.

8. TACTICAL CONNECTIVITY	Quartile	CTI
a. Provide timely I&W to all unit commanders.	I	1-A

    (1) (Mid-term) Provide real-time unevaluated I&W.

    (2) (Mid-term) Reduce by 50% the time for evaluated I&W.

    (3) (Far-term) Reduce by another 50% the time for evaluated I&W.

    (4) (Mid-term) Provide critical I&W to users in real time (tailored, essential).

b. (Mid-term) Provide common tactical picture to all users.   I   1-A
  (1) Provide commonality for data fusion of organic and non-organic sources of information.
  (2) Establish standard joint symbology set (color/B&W displays).
  (3) Provide access to all users, tailorable at the receiver.
  (4) Ensure real time data flow to all users.
  (5) Provide for warm (RED & BLUE) updates at the user end.
  (6) Ensure a common database, with updates in real time.
  (7) Provide configurable, noded network with Commander-level override.

c. (Mid-term) Provide secure interoperable voice comms to all users.   II   1-A
  (1) Render communications non-exploitable (unusable to target the transmitter) and non-interpretable by the enemy.
  (2) Ensure secure, anti-jam, anti-spoof voice.
  (3) Provide low probability of intercept/exploitation (LPI/LPE) voice/data channels.

d. (Mid-term) Provide secure data communications to all users.   II   1-A
  (1) Communications are non exploitable (unusable by the enemy to target the transmitter and non interpretable by the enemy).
  (2) Provide secure, anti-jam two way data links for platform to weapon, Commander to platform, and controller to weapon.
  (3) Maintain sufficient storage and throughput at each node for tactical databases.

e. (Mid-term) Provide accurate geopositioning to all users (platforms and weapons).   II   1-A
  (1) Provide position accurate to within 3 meters.
  (2) Provide a secure, jam resistant system for geopositioning.
  (3) Provide a system for the Commander that is portable/modular enough to allow common reporting from the unit level through platform level to the individual unit / man on the ground.
  (4) Improve accuracy to the point where targeting of individual weapons can be accomplished to an accuracy of 3 meters.

f. (Mid-term) Provide a flexible, reconfigurable, and interoperable   III   1-A
    tactical connectivity architecture.

    (1) Provide constant force positioning and status.

    (2) Provide command, control, and response network with real time
        response, tailorable to both Commanders' and users' needs.

    (3) Ensure open architecture that allows for compatible, insertion of new
        computer technology / language formats on continual basis.

    (4) Provide multiple chains / paths to ensure network localization where
        desired / required.

    (5) Provide multiple levels of security access for one network, multi-
        function use.

9. BOMB DAMAGE ASSESSMENT	Quartile	CTI
a. Provide bomb damage indication which allows:	I	1-B

    (1) (Mid-term) Report of bomb hit with failure assessment if
        unsuccessful within 30 seconds. (MOE: response in seconds)

    (2) (Far-term) Report of bomb hit with failure assessment if unsuccessful
        within 1 second.

    (3) (Mid-term) Sensor data which detects and records physical damage
        to a target which is highly resistant to environmental conditions and
        battle effects - 80%. (MOE: confidence factor)

    (4) (Far-term) Sensor data that detects and records physical damage to a
        target which is highly resistant to environmental conditions and battle
        effects - 95%.

    (5) (Mid-term) BDI/imagery data link (100 Mbytes/sec) between
        platform and battle commander. (MOE: data Mbytes/sec)

    (6) (Far-term) BDI/imagery data link (300 Mbytes/sec) between
        platform and battle commander.

b. Provide damage assessment which: I   1-B

    (1) (Mid-term) Allows analysis of functional capability damage with a
        high degree of certainty (P>.85) within the enemy's decision cycle
        (2.0 hours). (MOE: response time in hours)

    (2) (Far-term) Allows analysis of functional capability damage with a
        high degree of certainty (P>.85) within the enemy's decision cycle
        (0.5 hours). (MOE: response time in hours)

10. SHIP/SUBMARINE PLATFORMS (RELATED SYSTEMS)	Quartile	CTI

**a. (Mid-term) Develop shipboard systems that can operate in high sea   III / IV
states, at rates appropriate for future mission taskings.**
 (1) Expand ships' parameters for weapons launch (i.e., firing rate, shoot at
   faster speeds, shoot in any sea state, shoot from greater depths).
 (2) Enhance ships' sea-keeping for aircraft launch and recovery.
 (3) Develop rapid, reliable and safe weapons load, reload and test systems
   which provide a rapid fire rate while minimizing manpower.
 (4) Develop sufficient shipboard weapons protection systems to ensure
   survivability of onboard weapons and systems.

**b. (Mid-term) Provide capable shipboard systems to support future   IV
strike weapon systems.**
 (1) Provide shipboard energy-efficient, survivable power and auxiliary
   support for future weapon systems.
 (2) Develop systems that can be readily operated, maintained and repaired
   in a reduced-crew manning environment.

**c. (Far-term) Platform requirements for the far term are similar to those
for the mid term but the technologies developed will be incorporated
directly into new platform designs (vice backfits for mid-term platforms).**

Chapter 2

Joint Littoral Warfare

Strategic vision: Naval forces, in concert with joint and allied forces, must have the ability to rapidly and cost-effectively dominate the sea, air and land battlespace in order to project power in the littoral environment with a minimum of casualties.

LITTORAL WARFARE

Definition and Scope

Joint littoral warfare includes military operations conducted from seacoast regions to impose one's will on an adversary. It encompasses projection--or threat of projection--of force inland from the sea to attain operational objectives and to realize strategic aims. It is prosecuted primarily through naval operations but there may be a transition to sustained operations ashore. The joint littoral warfare domain includes the area from open ocean to inland areas that can be supported and influenced directly from the sea.

Joint littoral warfare involves the use of joint and allied forces in the world's littoral regions in tension and crisis. The term "joint littoral warfare" includes virtually all traditional naval missions as well as many non-traditional activities (such as maritime interdiction and humanitarian assistance), and "littoral" includes the transition from the deep ocean to the continental shelf (although the actual seaward and landward bounds of a littoral warfare operation are determined by the tactical situation).

Functional Description

Joint Littoral Warfare is characterized by certain attributes. The requirements of a warfighting operation vary greatly as it transitions from the open ocean to restricted waters and thence over land. Response-time-to-crisis is substantially reduced in near-land operations, and the environmental conditions of surf, tide, and acoustic and electromagnetic propagation become significant warfighting considerations. Track identification and targeting are more difficult because of terrain clutter and a relatively high density of shipping. Urban non-combatant populations often inhibit a force's freedom to maneuver and fight.

Joint Littoral Warfare can be thought of in terms of battlespaces: air, sea surface, undersea and land. Separating these areas is a convenient analytical tool but in an actual operation, each must be controlled simultaneously to achieve overall *battlespace dominance* in littoral warfare. "Battlespace dominance" in joint littoral warfare is defined as having total control of the air, sea surface, undersea and land battlespaces so that U.S. and allied forces can perform all desired operations while denying this ability to the enemy. Battlespace dominance includes free access from the sea, allowing unhindered entry of allied combat power into a littoral battlespace while also denying the enemy's access to the same littoral battlespace. Battlespace dominance ensures an effective transition from open ocean to littoral areas—from sea to land, and back—to enable the accomplishment of a full range of potential missions. Achieving battlespace dominance, the heart of naval warfare operations, is more difficult in the littoral than in the open ocean.

The 1994 Navy & Marine Corps paper *Forward...From The Sea* redefined the strategic concept for the employment of naval forces in the 21st century. The Navy's new direction is simply stated as maintaining the "...ability to project power from the sea in the critical littoral regions of the world." As with 1992's *...From the Sea*, this reaffirmed the Navy's change in focus to the littoral, where naval forces are used to influence events ashore while operating from sea bases in international waters. In broad terms, joint littoral warfare involves the combined use of joint or allied forces that are organized for forward operations in the sea, land and air environments to influence, deter, contain or defeat a regional littoral power through the projection of maritime power. Thus, Joint Littoral Warfare is now the principal focus of the modern Navy.

Traditional doctrine has focused on performing the two basic functions of naval warfare—power projection and sea control—through the accomplishment of a navy's principal warfare missions: air warfare, surface warfare, undersea warfare and mine warfare. In FY-1994 these areas were considered in separate S&T round tables. For FY-1995, following the lead of the Joint Mission Area assessment for Joint Littoral Warfare, the missions were considered in a single S&T round table. The components of the Joint Littoral Warfare round table included defensive as well as offensive capabilities; those components are as follows:

- Air Battlespace.
- Surface Battlespace--Land and Sea.
- Undersea Battlespace--Undersea Warfare and Antisubmarine Warfare (ASW); Mine Warfare.

This chapter describes each component separately but merges them in an overall prioritization.

Note on chapter organization: The three mission components (air, surface and undersea battlespace) are treated separately in terms of strategic vision, definition and domain, and functional description. Also noted for each component are those top-level functions that ranked in the first or second quartile of the combined top-level investment prioritization. In all, 36 top-level warfighting functions were identified for Joint Littoral Warfare. Their combined priority ranking appears in the Requirements subsection. Finally, prioritized goals and objectives for all 36 warfighting functions are described in Table 2. These represent the prioritized S&T Requirements (Classified requirements are given under separate cover) Also noted in Table 2 are fleet Command Technology Issues, which are mapped to related goals and objectives.

AIR BATTLESPACE

Strategic Vision: Provide U.S. and allied forces with the ability to rapidly and cost-effectively dominate the air battlespace of the world's littorals and thereby project power with minimum casualties.

Definition and Scope

The air battlespace extends from the earth's surface to the endo-atmosphere and it involves all above-ground forces including aircraft, missiles and directed energy weapons (e.g., lasers) whether friendly, hostile or neutral, and all surveillance assets, sensors, and command, control and communications capabilities that support operations in the air.

Functional Description

The principal objective of operations in the air battlespace is maintaining control of the skies and achieving battlespace dominance; that is, to fully neutralize enemy offensive and defensive weapons and allow U.S. and allied military forces to meet their joint littoral objectives with minimal losses. Aircraft threats include next-generation, multi-role attack aircraft, unmanned aerial vehicles, and slow flyers that stay low to the ground or sea. Missile threats include high-speed, terrain-hugging cruise missiles and medium range theater ballistic missiles. Laser or other directed energy weapons are relatively new and can be used against both personnel and equipment.

Weapons and aircraft in the air battlespace have improved significantly over the last several years. This is complicated by the proliferation of both U.S. and ex-Soviet equipment throughout Third World nations. In regional conflicts the U.S. may be required to fight against American-made aircraft belonging to a former ally and current adversary.

The air battlespace campaign can be divided into 11 top-level warfighting functions:

All-Source Data Fusion: Data fusion involves receiving track data from many sources, correlating data from different sources (e.g., different reports on the same track are correlated into a single track), and combining that data into information that is usable to the operator. The objective is to bring together, in as real-time as possible, the track data necessary for an operator to observe a tactical air picture and conduct his mission accordingly.

Knowledge of Own Forces: Friendly units report their positions by one means or another, so own-force track data is a subset of the all-source data listed above. This includes knowing the precise location and intended movements of U.S. and allied forces and the ability to communicate with these forces. The objective is to avoid BLUE-on-BLUE engagements, support the conduct of operations and planned maneuvers, and provide the ability to monitor the status of these operations and maneuvers.

Detection of Air Contacts: Detection is the act of using sensors to gain contact on an aircraft while isolating the target from clutter or countermeasures. Once a contact is detected, the next step is localization: maintaining sensor contact long enough to fix the contact's position.

Identification of Air Contacts: Identification involves all sensors, intelligence collection, and signal processing used to determine what the target is and what its intentions are. Identifying an air target (e.g., MiG 29) also includes classifying the target (e.g., hostile fighter aircraft). The objective of this function is to avoid BLUE-on-BLUE engagements, ensure weapons are only used on high-priority targets, and to select the best weapon for use against a particular target.

Control of Aircraft Sensors & Weapons: Control refers to the operator's ability to target a weapon system and guide the weapon onto the target. Control also involves decision aids that help in sensor and weapons management, the exchange of information between humans and machines, and the ability to provide fire control targeting information to weapons.

Engage & Destroy (or Neutralize): Once a decision to engage a target is made, the attacking unit must determine which weapon to use, assign that weapon to the target and enter a fire control solution, guide the weapon to intercept (as appropriate), and then assess the battle damage and decide whether to re-engage that target. This function may also require communication between multiple platforms, such as between an aircraft and a ship. The objective is to prevent the target from accomplishing its mission either by hard kill (destruction) or soft kill (neutralization through mission kill or decoy).

Aircraft Platforms & Propulsion: Aircraft are one of the primary tools used to dominate the air battlespace. Improvements in the design of airframes and their propulsion systems directly affect their performance in antiair warfare.

Aircraft Sustainability: Sustainability refers both to the ability of a given aircraft to remain in the air longer and to the availability of sufficient aircraft to maintain a constant presence or a given quantity of force. This includes the number of weapons carried, the distance they can be carried, and the logistics required to resupply the weapons and refuel the aircraft.

Aircraft Survivability: Survivability refers to an aircraft's ability to successfully perform its mission against hostile forces and retain sufficient capability for follow-on missions. This includes reducing signatures to avoid detection, using countermeasures to foil attacks, and aircraft hardening and other design technologies to improve the chances of surviving combat damage.

Aircraft External & Internal Communications: Reliable, unambiguous real-time communications between commanders and forces are required. This includes voice communications between humans (involving audio clarity and language translation) and data transmissions between computers.

Assessing Battle Damage: Near-real-time BDA of both hard kill or soft kill attacks is required in order to determine if a target survived and whether it should be reattacked.

Prioritized Top-level Functions

Of the warfighting functions (or functional requirements) listed above, the following were prioritized in Quartile I or II against all other functions related to Joint Littoral Warfare:

- All-source data fusion
- Air combat: engage & destroy (or neutralize)
- Air contact identification
- Air contact detection.

SURFACE BATTLESPACE

Strategic Vision: Provide U.S. and allied forces with the ability to rapidly and cost-effectively dominate the land and sea surface battlespace of the littorals of the world and thereby project power with minimum casualties.

Definition and Scope

In the context of Joint Littoral Warfare the surface battlespace is defined as the sea and land surface proximate to the littorals. Warfare within the surface battlespace, including traditional antisurface warfare and over-the-horizon targeting, involves the full spectrum of maritime forces in the accomplishment of specific military objectives and overall battlespace dominance. These operations include the application of force to maintain sea control at sea and thereby to project power over land.

Domination of the surface battlespace includes both controlling the littoral seas and the ability to move personnel and equipment ashore from the sea (including also special operations forces in clandestine operations). Warfare in littoral regions emphasizes ship self defense against attack, the movement of troops ashore, and supporting gunfire from ships. The objectives of surface warfare are to maintain control of the sea, provide the ability for U.S. and allied ships to operate freely, and with that freedom of action to make the beaches and surrounding areas safe for landing by amphibious forces.

Functional Description

The surface battlespace campaign is divided into seven warfighting functions:

Ship Self Defense: Self defense involves all aspects of ship survivability: defensive weapons, sensors, signature suppression, hardening technologies, countermeasures, and damage control equipment and procedures that collectively prevent or limit combat damage from enemy fire.

Surface Fire Support: Naval gunfire support involves the weapons, support equipment, personnel and tactics used to achieve the objective of making the beaches safe for landing and protecting the personnel and equipment located ashore.

Ship-to-Objective Maneuver: Ship to objective movement involves all amphibious vehicles, craft, loading and unloading equipment, and site preparation equipment used to move weapons, equipment, and personnel to land.

Amphibious Operations Ashore: Marine Corps operations ashore involve all combat, communications and expeditionary activities performed on land. Wartime activities include securing beaches and land areas, capturing specific facilities, and destroying targets not reachable by other means. Peacetime activities include humanitarian efforts, disaster relief, and peacekeeping missions.

Weapons Against Other Maritime Surface Targets: Other surface targets include ships and craft (e.g., patrol boats, mine layers, air cushioned landing craft (LCACs)), missile batteries, and beachfront artillery sites.

Special & Unconventional Operations: Special operations involve the covert employment of special operations forces (SOF) in missions such as reconnaissance, neutralization of targets, BDA and rescue that are smaller in scope or more specialized.

Maritime Interdiction of Merchant Shipping: Maritime interdiction includes efforts to stop illegal trafficking in drugs, weapons, people (e.g., illegal immigration) or other contraband and recently has become a key aspect of enforcing United Nations sanctions.

Prioritized Top-level Functions

Of the warfighting functions (or functional requirements) listed above, the following were prioritized in Quartile I or II against all other functions related to Joint Littoral Warfare:
- Ship self defense
- Ship-to-objective maneuver
- Naval surface fire support
- Marine Corps operations ashore.

UNDERSEA BATTLESPACE

Strategic Vision: Provide U.S. and allied forces with the ability to rapidly and cost-effectively dominate the undersea battlespace of the littorals of the world, and to operate unimpeded by the threat of mines and obstacles, and thereby project power with minimum casualties.

Definition and Scope

The undersea battlespace is the area below the surface of the world's seas down to and including the ocean floor. The scope of undersea operations is to enable use of this space by allied forces while denying its use to enemy forces. There are two major categories of undersea operations: undersea warfare (including ASW) and mine warfare.

Domination of the undersea battlespace is driven by the ability to maintain a level of surveillance capability adequate to determine the presence of hostile submarines and mines. Littoral ASW and mine warfare are noteworthy in that shallow water normally presents a difficult acoustic environment. Proximity to the surface is an advantage in most non-acoustic detection methods. Undersea warfare in littoral regions emphasizes mine countermeasures (MCM) by active and passive methods, neutralization of underwater submarine threats, and various command, control, communications, computers and intelligence (C^4I) and environmental physics issues.

Functional Description

Undersea Warfare and ASW. The objectives are to maintain control of the sea and provide the ability for U.S. and allied ships and submarines to operate freely. The undersea warfare and ASW campaign can be divided into the six warfighting functions reviewed below:

Underwater Threat Neutralization: Neutralization of an undersea threat occurs when an enemy submarine is rendered incapable of firing or when its weapon is destroyed (hard kill), and when the enemy's sensors are rendered incapable of detecting an undersea target or its weapon is unable to acquire the target (soft kill).

Submarine Survivability: This component addresses submarine design using low-observable technology, unit tactics to minimize detection and increase the probability of surviving an attack, undersea identification friend-foe (IFF) and countermeasures.

Undersea Coordination & Tactical Control: Coordination and control addresses the ability to command and control (C^2) U.S. and allied submarines with emphasis on the undersea surveillance assets used to obtain track data, maintenance of a tactical picture, and the ability to communicate with submerged submarines.

Undersea Surveillance: Surveillance of the undersea battlespace, a key to submarine survivability and undersea C^2, addresses the sensors and systems used to search, detect, classify, localize and track enemy submarines.

Submarine Covert & Non-covert I&W: Indications and warnings (I&W) involve collection of acoustics, signals, communications and other data; and using it to predict enemy actions.

Undersea Environmental Assessment: This assessment involves the oceanographic and meteorological environments and attempts to assess their influence on undersea sensors, systems and operations. An emphasis is placed on surveys, *in-situ* data collection, an ability to predict environmental conditions, and an ability to share this data and these predictions.

Of the warfighting functions (or functional requirements) listed above, the following five were prioritized in Quartiles I or II against all other functions related to Joint Littoral Warfare:
- Underwater threat neutralization
- Undersea coordination and tactical control
- Undersea environmental assessment

- Surveillance of the undersea battlespace
- Submarine survivability.

Mine Warfare. Mines are a relatively cheap way to deny access to an ocean area and otherwise disrupt maritime traffic. Through their use, commercial and military ports can be closed, the sea lanes can be shaped and controlled, and beaches can be protected against amphibious landing. Some mines sink to the bottom, others are buoyant and are tethered some distance below the surface, and still others float and drift on the surface. But all mines lie still and are silent, making their detection and avoidance particularly difficult. The objectives of mine warfare are twofold:

- To maintain control of the sea, and the ability for U.S. and allied ships and submarines to operate free of threat from enemy mines, and
- To use selective mining as a tool to inhibit an enemy's freedom to operate by closing ports or sea routes to his shipping traffic.

Mine warfare functional activities can be divided into three general areas:

Mines & Mining: Minelaying requires the ability to deliver mines with precision and record their locations for own-force avoidance (and later removal). A related aspect of mining is C^4I support to the mine layers and an ability to perform remote control of a laid minefield.

Mine Countermeasures: MCM refers both to offensive and defensive mine prevention, detection and removal. Offensive MCM involves destroying enemy mine production facilities, stockpiles or minelaying ships and, being preventative in nature, is the most effective form of MCM. Defensive MCM is divided into passive and active methods, where the former refers to signature reduction and mine avoidance, and the latter refers to active hunting and sweeping.

Mine Warfare Effectiveness and Readiness: This refers to achieving a better understanding of the undersea environment where the mines will be placed, developing training systems for mining and mine countermeasures, and providing better support in mission planning.

Of the warfighting functions (or functional requirements) listed above, only the following were prioritized in Quartile I or II against all other functions related to Joint Littoral Warfare:

- Defensive MCM using both active and passive methods
- Mine warfare C^4I
- Offensive MCM.

Requirements

Underlying the strategic vision for Joint Littoral Warfare, 36 top-level warfighting functions were prioritized as follows (and grouped by round table quartile):

1. **SHIP SELF DEFENSE (INCLUDING VERSUS SEA SKIMMER).**
2. **SHIP-TO-OBJECTIVE MANEUVER (INCL. NON-COMBATANT EVACUATION).**
3. **MCM: DEFENSIVE MISSION USING ACTIVE METHODS.**

4.   **ALL-SOURCE DATA FUSION.**
5.   **MCM: DEFENSIVE MISSION USING PASSIVE METHODS.**
6.   **AIR COMBAT: ENGAGE & DESTROY (OR NEUTRALIZE).**
7.   **UNDERSEA THREAT NEUTRALIZATION.**
8.   **NAVAL SURFACE FIRE SUPPORT.**
9.   **UNDERSEA COORDINATION & TACTICAL CONTROL.**
10. **MINE WARFARE: C⁴I.**
11. **AIR CONTACT IDENTIFICATION.**
12. **OPERATIONS ASHORE (MARINE CORPS).**
13. **UNDERSEA ENVIRONMENTAL ASSESSMENT.**
14. **AIR CONTACT DETECTION.**
15. **SURVEILLANCE OF THE UNDERSEA BATTLESPACE.**
16. **OFFENSIVE MCM.**
17. **UNDERSEA FORCE/UNIT SURVIVABILITY.**

18. **UNDERSEA COVERT/NON-COVERT INDICATION & WARNING.**
19. **KNOWLEDGE OF OWN FORCES.**
20. **SPECIAL/UNCONVENTIONAL OPERATIONS.**
21. **MINE COUNTER-COUNTERMEASURES.**
22. **ENVIRONMENTAL PHYSICS OF MINE WARFARE.**
23. **WEAPONS AGAINST OTHER MARITIME SURFACE TARGETS**
24. **AIR BATTLESPACE SURVIVABILITY.**
25. **AIRCRAFT PLATFORMS & PROPULSION.**
26. **REMOTE CONTROL OF MINEFIELDS.**

27. **MINE DELIVERY.**
28. **AIRCRAFT EXTERNAL & INTERNAL COMMUNICATIONS.**
29. **MARITIME INTERDICTION (OF MERCHANT SHIPPING).**
30. **MINE EFFECTIVENESS.**
31. **ASSESSING BATTLE DAMAGE.**
32. **AIRCRAFT SUSTAINABILITY.**
33. **CONTROL OF AIRCRAFT SENSORS AND WEAPONS.**
34. **MINEFIELD PLANNING.**
35. **MINE TRAINING SYSTEMS.**
36. **MINE WARFARE TRAINING SYSTEMS.**

Table 2 lists prioritized goals and objectives under each of the 36 top-level warfighting functions.
These goals and objectives represent S&T requirements for Joint Littoral Warfare. Priority is
indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low
priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues
(CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column.
The alphanumerics refer to Joint Littoral-related paragraphs in the CTIs, published verbatim in

Appendix 2. For reference, Appendix 2 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 2. JOINT LITTORAL WARFARE: PRIORITIZED S&T REQUIREMENTS		

1. SHIP SELF DEFENSE (INCL. VERSUS SEA SKIMMER)	Quartile	CTI
a. (Mid-term) Develop the capability for an organic force to detect, identify and successfully engage low-observable, high-speed and highly maneuverable, low- to high-altitude targets within the horizon and in severe environmental and countermeasures environments.	I	2-C
b. (Mid-term) Develop the capability to detect, identify and engage small, low-speed multiple surface threats while operating in severe environmental and countermeasures environments.	I	2-C
c. (Far-term) Develop the capability to detect, identify and successfully engage with organic assets multiple low-observable, high-speed and highly maneuverable, low- to high-altitude targets at over-the-horizon ranges while operating in severe environmental and countermeasures environments.	I	2-C
d. Improve shipboard threat detection capabilities to counter low-observable technologies, electronic counter-countermeasures (ECCM), and clutter in various environmental and countermeasures environments.	I	2-C
e. Improve shipboard capabilities to perform over-the-horizon (OTH) target identification, target localization, and knowledge of the environment in the target's area in various environmental and countermeasures environments.	I	2-C
f. Develop credible, reliable IFF techniques that are covert, secure, and jam-resistant and are able to provide the identifications and positions of multiple OTH surface contacts (including friends, foes and neutrals) in various environmental and countermeasures environments.	I	2-I
g. (Mid-term) Provide highly survivable surface combatants with features that include damage resistance and control, low signature, high operability and effective countermeasures.	I	2-C
h. Provide improved capabilities for mapping the battlefield using systems that are covert (e.g., passive, low probability of intercept/detection (LPI/LPD)), are of high endurance, and work in various environmental and countermeasures environments. (This is the same capability needed for naval surface fire support (NSFS)).	I	

i. Develop renewable weapons, such as directed energy weapons (e.g., lasers), that are agile, easy to target, need little logistics support, are compatible with a shipboard electromagnetic (EM) environment and can deliver both lethal and non-lethal charges in all types of weather against both surface and low-altitude air targets.   I   2-E

j. Improve shipboard capabilities to detect, identify, and coordinate the engagement of multiple surface and air targets and provide a near instantaneous kill-assessment, both for hard kill and soft kill engagements, in various environmental and countermeasures environments.   I   2-C

k. Provide the capability for real-time, all-source data fusion that provides value-added information to the commander (vice raw data) on both surface and air targets. This system must be capable of transferring large amounts of data, including imagery, in real time and at multiple levels of security. (Same capability needed for NSFS.)   I   2-C

l. Develop fire control systems (FCS) and supporting sensors that can track with increased accuracy and resolution, develop range information, work in various environmental and countermeasures environments and have high data rates to feed timely information to their weapons. These systems must also be able to discriminate between targets, decoys, and clutter.   II

m. Develop the capability for autonomous target recognition systems that can, in real-time and in all types of weather, distinguish a hostile air or small surface contact from background tracks, false targets, and other clutter.   II   2-C

n. Develop technologies to reduce and/or control the electro-optical (EO) signature of ships via coatings, cloaking or reconfigurable camouflage.   II

o. Improve the survivability of ships against attack by developing improved armor materials for use in ship design.   II   2-C

p. Improve the hardening techniques used in ship design to protect the crew against chemical, biological and radioactive weapons.   II   2-C

q. Develop the technology to permit multi-spectral signature reduction via coatings or hull shaping to reduce the radar cross section of ships and to reduce the radiation of antennas and other sensors.   II   2-C

r. Develop a tactical decision aid (TDA) that allows input of *in- situ* measurements of the environment and target signatures, provides modeling of target signatures, incorporates an understanding of the involved physics and interfaces (sea, air, land), and provides the operator with a tactically useful display.   III   2-C

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s. Improve the predictors for sensor and weapons performance so that they operate in real time (perhaps using the TDA from above) and can be used as TDAs. **III**

t. Develop improved gun/missile propellant that has a higher energy content and is more insensitive, possibly including low-cost turbines in the design or taking advantage of electro-chemical or electro-thermal effects. **III** 2-C

u. Improve the technology to reduce ships' acoustic signatures by developing quieter propulsors, improved acoustic coatings, machinery silencing techniques, hydroacoustic silencing techniques and/or active noise control methods. **III** 2-A

v. Improve the technology to reduce ships' magnetic signatures by developing the capability for closed loop degaussing and active field suppression, and by a greater use of non-magnetic materials and/or variable moment magnets. **III** 2-A

w. Improve the technology to reduce and/or control ships' infrared (IR) signatures, possibly by the use of material treatments, active cooling systems or improvements in the design of propulsion systems. **III**

x. Develop a large volume coverage capability for submunitions, possibly involving the use of flak. **IV**

y. Improve the design of fusing on smart weapons so that the fuse is not triggered by ground or water when engaging surface, low-altitude air or sea skimming targets. **IV** 2-C

z. Improve the technology to reduce and/or control ships' radio frequency (RF) signatures through low probability of intercept (LPI) technologies, perhaps via frequency techniques or burst communications. **IV**

aa. Design cheap, dumb, powerful bullets and a gun system that permits improved accuracy and smaller dispersion. **IV**

ab. Improve the technology to reduce and/or control a ships' wake signature, possibly via modified hull designs, modified propulsor designs or by surfactants. **IV** 2-C

2. SHIP-TO-OBJECTIVE MANEUVER (INCLUDING NON-COMBATANT EVACUATION)	Quartile	CTI

a. (Mid-term) Field an advanced amphibious assault vehicle (AAAV) per the following specifications: **I**

(1) Speed over water at least 25 knots.
(2) Speed over land at least as fast as a main battle tank.
(3) Vehicle capacity of 16-18 combat-loaded Marines (reinforced squad).
(4) Ride over land must permit Marines to conduct intense combat operations immediately upon exit.

b. (Mid-term) Field a replacement surface heavy lift utility landing craft (LCU) vehicle per the following specification: I
(1) Cargo capacity of at least 140 tons
(2) Permits initial combat capability offload on first day
(3) Designed for incremental stand-up over three days (given that logistics support remains largely sea based).

c. (Mid-term) Develop a real-time C^4I capability to provide the following support to landing forces engaged in an amphibious assault: II 2-H
(1) Command and control of landing craft
(2) Integration of naval gunfire support and close air support into the assault plan
(3) Intelligence support on enemy locations and order of battle (OOB).

d. (Mid-term) Develop systems and techniques to permit the standup of a maritime prepositioned force (MPF) in fewer than ten days. IV

e. (Far-term) Replace the existing MPS fleet with a government-owned fleet of ships per the following specification: IV
(1) Designed to include advanced materiel handling, tracking and offload systems
(2) Designed to permit the stand-up of an MPF in three days or less.

3. MCM: DEFENSIVE MISSION USING ACTIVE METHODS	Quartile	CTI
a. Develop the ability to conduct in-stride, deliberate clearing and/or breaching of mines and obstacles (cement blocks, barbed wire, etc.) from over the horizon to the amphibious craft landing zone (CLZ); specifically, clear at least 25 nm in less than 2 hours.	I	2-A
b. Develop the capability to detect and localize mines at a minimum search speed of at least the maximum of a task force's, convoy's, or single unit's speed of advance; and detect, classify, localize, and positively identify mines over a given sea or land front at an optimum survivable speed.	I	2-A
c. Develop the capability to locate detected mine-like contacts with sufficient accuracy for subsequent avoidance and prosecution.	I	2-A
d. Develop the capability to use unmanned, offboard platforms to detect, classify, identify, localize, and tag mines, neutralize these mines using defensive systems without constraining the ship's speed or requiring it to maneuver.	I	2-A

e. **Develop the capability to deploy a remotely operated influence sweep**   I   2-A
   that emulates the signatures of traffic requiring protection from mines
   per the following specifications:
   (1) Sweep system should be lightweight, low-drag, deployable from air.
   (2) System should be controllable from a variety of platforms.
   (3) Sweep must offer high-fidelity emulation of magnetic, electric,
       acoustic and seismic signatures.

f. **Develop the technology to deploy rapid, unmanned mine**   III   2-A
   neutralization system(s) that are effective against bottom, moored and
   drifting mines, are low-cost (e.g., expendable), and can optically
   identify the mine being neutralized.

4. ALL-SOURCE DATA FUSION	Quartile	CTI

a. **Develop a C^{4}I architecture that supports data fusion from all-sources**   I   2-C
   and disseminates a fused, real-time, unambiguous picture to
   underway ships and aircraft in the air.

   (1) Develop a "fusion engine" that supports automatic correlation and
       fusion of dissimilar sensor, data source or report information (e.g.,
       fusion engine should universally parse and extract data from any type
       of joint or allied tactical data report).

   (2) Develop systems to support: fusion of both organic and non-organic
       data in real-time, automatic prioritization of certain types of reports or
       tracks, automatic filtering of lower priority contact reports, and a real-
       time depiction of own-force disposition.

   (3) Develop high-bandwidth and high-speed communications paths for the
       dissemination of the fused tactical picture, possibly using gigahertz
       (GHz) datalinks or video signals.

5. MCM: DEFENSIVE MISSION USING PASSIVE METHODS	Quartile	CTI

a. **Develop the capability to detect and avoid mines out to 2000 yards by**   I   2-A
   organic means. Note: "Organic" depends on the makeup of the
   functional unit (e.g., ship, task force, carrier battlegroup).

b. **Develop the capability to conduct mine and obstacle reconnaissance of**   I   2-A
   an amphibious operations area (AOA) during the advance phase of an
   amphibious operation. Note: A nominal AOA is considered to include
   200 nm of coastline, 8 days of required availability, and 50 nm
   standoff from the beach.

c. **Reduce and/or mask the acoustic, electromagnetic and pressure**   I   2-A
   signatures of ships and submarines to levels commensurate with
   current and projected threat.

6. AIR COMBAT: ENGAGE & DESTROY (OR NEUTRALIZE)	Quartile	CTI
a. (Far-term) Develop an air-launched missile with multi-mode capability that has at least two (and preferably several) onboard sensors and can perform stand-alone track correlation or link with external sensors for target correlation and decoy avoidance.	I	2-C
b. (Mid-term) Develop a highly maneuverable weapon with improved kill capability per the following specifications:	I	2-C

(1) Able to maneuver at between 100-150 G and engage a 20 G unmanned aircraft or a 50 G missile.

(2) Fitted with an advanced, dual-thrust rocket motor capable of Mach 6-8 and a maximum range of at least 250 nm.
(3) Able to perform autonomous flight control, precise homing with a hit-to-kill guidance solution.
(4) Equipped with a high-speed TDD/fuse and advanced discrimination logic.
(5) Fitted with a warhead containing high-capacity explosive technology and improved penetrator technology.
(6) Equipped with a kill mechanism that is improved over today's kinetic energy transfer methods.

| **c. (Far-term) Develop an air-launched weapon capable of engaging inbound cruise missiles, anti-air missiles and theater ballistic missiles (TBMs) per the following specifications:** | I | 2-C 2-D |

(1) Compatible with all services' tactical aircraft.
(2) Capable of inflight programming.
(3) Capable of kinematic performance from sea level to endo-atmospheric.
(4) Fitted with more precise homing and hit-to-kill guidance solution.
(5) Capable of engaging TBMs in their boost or ascent phases of flight.

| **d. (Far-term) Design a directed energy (speed of light) weapon for use aboard tactical aircraft per the following specifications:** | II | 2-C 2-D |

(1) Designed to minimal size, weight and plumbing requirements.
(2) Designed to provide a deep magazine.
(3) Suitable for use aboard aircraft or surface ships.
(4) Maximum effective range at least 50 nm.
(5) Designed to require minimal engagement time.
(6) Designed to permit multiple, simultaneous target engagements.

| **e. (Far-term) Design an air-launched weapon system that can target using very low observable detection and tracking methods, possibly including sensor capability against other aspects of target signature (such as heat, molecular displacement, etc.).** | II | |

f. **(Mid-term) Design an air-launched weapon that is virtually decoy proof and includes multi-mode on-board decoy discrimination capability (including optical, IR, electronic support measures (ESM), RF, etc.) and an advanced IFF/non-cooperative target recognition (NCTR) capability.** II

g. **(Mid-term) Design an air-launched weapon with multiple target capability per the following specifications:** II 2-C
   (1) Able to engage 18 targets in 30 seconds
   (2) Designed with engagement system operational availability (Ao) = 0.99
   (3) Equipped with precision aiming and guidance: one shot, one kill
   (4) Designed with a deep magazine.

h. **Design a multi-target capable guided gun for shipboard use close-in against small boats, sea skimmers, aircraft, submarines, mines, etc.** II 2-C

i. **Design a weapon system that can be targeted using purely passive methods and a missile whose terminal homing is also passive (perhaps involving infrared, electro-optical, or command guidance methods).** II

7. UNDERSEA THREAT NEUTRALIZATION.	Quartile	CTI

Note: See appendix for classified requirements.

a. **Develop systems to better neutralize threats posed by hostile subs, mini-subs, moored homing torpedoes and other unmanned underwater vehicles (UUVs) per the following specifications:** I 2-B
   (1) Improve torpedo acoustic homing technologies to permit homing on low-Doppler signatures in acoustically cluttered or shallow water in the presence of countermeasures (e.g., new technology to mask/ignore acoustic returns from clutter, bottom echoes, reverberations, etc.).
   (2) Develop the capability to remotely mark or tag ASW mines.
   (3) Develop airborne ASW sensors that can detect low-signature subs.
   (4) Develop non-lethal weapons to provide a quick-reaction but non-destructive neutralization capability.

b. **(Mid-term) Develop improvements in torpedo technology per the following specifications:** I 2-B

(1) Achieve an X dB improvement in signal-to-noise ratio (S/N) for acoustic detection, classification and homing against submarines in shallow water with both low-Doppler ($\leq$ X kts) returns and a faint acoustic signal strength ($\leq$X dB).

(2) Provide the capability for *in-situ* measurement and on-board adaptation of the gidance and control (G&C) system in the highly variable shallow-water environment. This possibly could involve the development of new sensors, new procedures for the use of existing sensors, or new technologies in beam forming, signal processing, or similar.

(3) Provide the capability for terminal homing against small, bottomed or near-surface targets with a probability of kill (P_k) of $\geq$ X and the automatic selection of hit location.

(4) Develop environmentally safe explosives, fuels & propulsion systems.

(5) Reduce overall weapons life-cycle costs in procurement, training and exercising, infrastructure requirements and logistics support; examine FMS sales as a method to increase production and reduce unit cost.

(6) Reduce a torpedo's flow, propulsor and machinery noise to make them as quiet as the submarine launch platform.

(7) Develop the capability for a torpedo to perform IFF queries as method to prevent attack against the launching ship while maintaining an open azimuth for attacking the intended target.

(8) Develop the capability to perform a quiet torpedo launch without maneuver constraints on the launching platform.

c. **(Far-term) Achieve torpedo performance levels in shallow water that are equivalent to or better than today's capabilities in deep water (while maintaining superior performance in deep water).**   I   2-B

d. **Develop improved systems to better detect, classify and neutralize (destroy or defuse) the threat posed by mines.**   I   2-A

e. **Develop improved systems to better neutralize the threat posed by enemy torpedoes per the following specifications:**   I   2-B
    2-C

(1) (Mid-term) Design defensive and other systems to ensure the probability of survival is $\geq$ X against a torpedo inbound from any aspect angle.

(2) (Mid-term) Develop improved and fully automatic systems to detect, classify, identify and target incoming torpedoes and provide a layered defense in all environments.

(3) (Far-term) Provide the above capability against salvos of torpedoes in all environments and in the presence of countermeasures.

(4) Develop improved countermeasures and decoys.

(5) Develop improved weapons for use against inbound torpedoes; develop better fusing technologies that emphasize safety of the launching ship.

f. **Develop an improved capability to neutralize an adversary's sensor**   **III**
systems and arrays per the following specifications:
   (1) (Mid-term) Deny the enemy an ability to detect, identify and target U.S.
        submarines, possibly through the use of signature control methods or
        the use of improved acoustic or nonacoustic countermeasures.
   (2) (Far-term) Develop improved methods to covertly locate and neutralize
        enemy sensors and arrays, possibly through the use of UUVs.
   (3) Develop improved technologies to control a ship's or submarine's own
        signature (including self-noise quieting or signature masking).

8. NAVAL SURFACE FIRE SUPPORT	Quartile	CTI
a. **Improve the real-time capability to determine the identification (ID) of shore targets, localize shore targets, and gain knowledge of the weather ashore while in a variety of weather conditions at sea and/or while at over-the-horizon (OTH) ranges.**	I	
b. **Provide improved capabilities for real-time mapping of the battlefield using systems that are covert (e.g., passive, LPI/LPD), are of high endurance and work in a variety of weather conditions. (This is the same capability needed for Ship Self Defense.)**	I	
c. **Provide capability for real-time, all-source data fusion with data processing that provides value-added information to the commander (vice raw data) on the operational situation ashore. Must be able to transfer large amounts of data (incl. imagery) in real time and at multiple levels of security. (Same ability needed for Ship Self Defense.)**	I	
d. **Design battle damage assessment (BDA) systems that provide auto cueing, can be deployed rapidly, have high endurance and are fully directable. (Note: Auto cueing occurs when the system recognizes changes from one image to another and adjusts itself without human intervention.)**	I	
e. **(Far-term) Develop the capability to perform real-time target detection, classification, identification, localization, targeting and BDA.**	I	
f. **Develop more flexible fire control systems (FCS) that: are fully integrated with the mission planning tools, are interfaced directly to global positioning systems (GPS), and provide the ability to direct mid-course corrections to a weapon in flight.**	I	
g. **Develop autonomous target recognition systems that can, in real-time, distinguish a specific shore target from background targets, false targets and other clutter.**	II	2-G

h. **(Mid-term) Develop a precision guided munition (PGM) for the 5-inch**   **II**   **2-G**
    gun per the following specifications:
    (1) Payload of 24-40 pounds
    (2) Range of 40 nm (conventional round in a 5-inch gun)
    (3) Range of 75 nm (adv. propulsion gun with twice the muzzle energy)
    (4) CEP of less than 20 m (non-GPS guided)
    (5) CEP of less than 2 m (GPS guided)
    (6) Built-in terminal seeker (e.g., mm wave, I^2R, EO, SAL).

i. **(Mid-term) Develop improved targeting and communications systems,**   **II**   **2-G**
    specifically tailored to support precision guided munitions (PGM) and
    cruise missiles currently in the inventory (and also those weapons
    planned for the mid-term future; see below), per the following
    specifications:
    (1) Targeting and terminal guidance based on localization by GPS
    (2) Targeting and terminal guidance to include input of such data as target
        image, target aspect angle, target's relative position to other objects
        (e.g., third building in a row of five), and target depth (e.g., detonate
        after penetration).

j. **(Mid-term) Develop a lower-cost, precision-guided cruise missile per**   **II**   **2-G**
    the following specifications:
    (1) Warhead size of 500 pounds (approximately)
    (2) Fly away cost of less than $150,000
    (3) Range of greater than 100 nm
    (4) Sized to fit in vertical launch system (VLS) tube; i.e., 21-inch
    diameter.

k. **Design mission planning tools that are fast and flexible, interface with**   **II**
    the FCS, can be integrated with other strike platforms, and have
    enough knowledge of targets and weapons systems to give
    probabilistic yet accurate results.

l. **Improve propulsion systems, including the combination of launcher**   **II**   **2-G**
    and projectile, to increase gun and missile ranges while maintaining
    shore targeting precision.

m. **Develop submunitions variants that are appropriate for given target**   **III**   **2-G**
    sets (e.g., based on target size, location, etc.) to permit a distribution of
    firepower against shore targets including between several targets or
    between areas within a single target.

n. **Improve on the design of conventional munitions to permit longer**   **III**   **2-G**
    ranges (possibly via wave rider or drag reduction technology),
    increased payload capacity, greater structural strength and a
    capability against hard targets ashore.

o. **Improve navigation positioning systems such that they are jam**   **III**
    resistant, provide "six degrees of freedom" information, have an
    integral backup system, and provide better accuracy and resolution
    than does GPS.

p. **Provide the capability for real-time weather forecasting and "now**   **IV**
    casting".

q. **(Mid-term) Improve the lethality of small (e.g., 5-inch) warheads per**   **IV**   **2-G**
    the following specifications:
    (1) Able to penetrate rolled, homogeneous armor (RMA) to a depth of 500
         to 12000 mm
    (2) Able to effect blast damage/destruction of aero structures at a standoff
         distance of 2 m.

r. **(Far-term) Develop cost effective cargo round payloads (e.g., surface**   **IV**
    to air defensive anti radiation missile (SADARM), BAT).

s. **(Mid-term) Develop a long-range 5-inch gun per the following**   **IV**   **2-G**
    specifications:

    (1) Range of up to 75 nm with aero-RAP PGM rounds
    (2) Range of up to 25 m with conventional rounds.

t. **(Far-term) Develop an advanced, major-caliber gun (e.g., 155 mm),**   **IV**   **2-G**
    possibly as a joint Army-Navy-NATO program.

9. UNDERSEA COORDINATION & TACTICAL CONTROL	Quartile	CTI
a. (Mid-term) Establish the capability to develop and maintain a real-time common tactical picture of all underwater forces, derived from a fusion of multi-sensor and multi-platform data, with the completeness and accuracy to ensure zero BLUE-on-BLUE attacks are made and keep the false attack rate to something less than X%. Implement this capability as follows: (1) Provide real-time communication paths and techniques that work at all depths and have sufficient bandwidth for passing imagery. (2) Provide the capability for automatic data fusion and force-wide dissemination of the common tactical picture. (3) Ensure compatibility with other tactical data systems through the use of progressive versions of common software modules, common tactical data bases, common graphical displays, common symbols and common formats. (4) Ensure the fused tactical picture is internally disseminated to other workstations on the submarine via a local area network (LAN).	I	2-B
b. (Mid-term) Develop the capability to maintain control of the undersea battlespace and thereby enable expeditionary forces to accomplish their assigned missions.	I	2-B
c. (Far-term) Establish a common, multi-platform tactical database management system with seamless and secure C^4I communications connectivity between all participating forces per the following specifications: (1) Able to provide 100% synchronization of the tactical data between all participating assets. (2) Able to provide real-time updates of this data (e.g., $\leq$ X second delay in receipt).	I	2-B
d. (Mid-term) Provide the capability to coordinate multi-platform resource assignments, direct and control necessary engagements, and provide an assessment of engagement results (i.e., a goal of $\geq$X% correctness) through the use of a model of multi-platform capabilities and effectiveness.	II	2-B
e. (Mid-term) Develop the capability to produce real-time, *in situ* sensor and weapon performance predictions with an accuracy of $\geq$X% correctness.	II	2-B
f. (Mid-term) Establish the capability for submarine I&W systems to provide tactical information that adds to the common tactical database.	II	2-B

g. (Mid-term) Develop standardized, multi-functional, multi-media all-source tactical data terminals that support all submarine mission requirements (including communications), possibly through a tailoring of the Navy's Joint Maritime Command Information System (JMCIS).   II   2-B

h. (Mid-term) Provide the capability for submarines to receive and integrate all multi-media and multi-format information received via the Joint Tactical Information Distribution System (JTIDS), Link 11 or NATO's Link 22.   II   2-B

i. (Mid-term) Develop the capability for a submarine to maintain continuous super high frequency (SHF) connectivity to support maintenance of the joint common tactical picture and uninterrupted participation in the Joint Targeting Network (JTN).   II

j. (Far-term) Develop a human/computer interface that improves tactical decision making and database management, possibly through the use of artificial intelligence applications.   III

10. MINE WARFARE: C^4I	Quartile	CTI
a. Provide mine warfare (MIW) assessments that are compatible with and integrated into overall Navy C^4I systems and architectures (i.e., connectivity, capacity, data correlation, data fusion and interoperability). Note: This capability must exist within MCM force elements, the task force, supporting forces and the chain of command.	II	2-A

11. AIR CONTACT IDENTIFICATION	Quartile	CTI
a. (Mid-term) Develop the technology to perform a cooperative identification of own forces upon detection and with virtually 100 percent accuracy in order to enable the following types of engagements: (1) Use of air-launched weapons at maximum weapons range. (2) Covert (undetected) use of weapons from air platforms. (3) Ability to discriminate between targets within 5 nm of each other (e.g., a group of friendly and hostile aircraft in proximity, as seen from a third party). (4) Ability to perform a raid count of inbound targets (e.g., up to 8 in close proximity).	I	2-C 2-D
b. (Far-term) Develop systems to perform theater fusion of air contact identification data that is received from all sources and delivered to tactical aircraft in real-time.	I	2-C
c. (Far-term) Develop the capability to perform all-weather identification, data fusion and real-time dissemination of cooperating and non-cooperative air tracks.	I	2-C

d. **Develop the capability to classify potential targets as friend, foe, or neutral as early as possible after initial detection per the following specifications:**	I	2-C

(1) Determine the classification of air targets (aircraft, missiles, and helicopters) by type and mission (e.g. MiG 27 or MiG 29, SCUD or Exocet).

(2) Catalog signature characterizations in all spectrums by target classification.

(3) Improve the capability to discriminate targets from decoys.

(4) Perform target identification and classification simultaneously with target detection.

(5) Permit high-resolution imaging.

12. OPERATIONS ASHORE (MARINE CORPS)	Quartile	CTI
a. **(Mid-term) Develop a unit-transportable system to provide fully integrated, joint force and all-source C^{4}I data delivery to troops on the ground that can be sized to the unit's capability to deploy/transport; specifically:**	II	2-F 2-H

(1) Transportable in a highly mobile multi-purpose wheeled vehicle (HMMWV) for a MEW/battalion landing force (BLT)

(2) Transportable in a S-250 shelter mounted on a 5-ton truck for a regimental landing force (RLT)/Air Group

(3) Transportable in multiple S-250 shelters for a marine expeditionary force (MEF)/DIV/Wing.

b. **(Mid-term) Develop systems to provide tactical IFF and combat ID to a rifle squad engaged in combat.**	II	
c. **(Mid-term) Improve the survivability and lethality of each Marine while also lightening the load he must carry.**	II	2-H
d. **(Far-term) Develop advanced artillery systems to include guns, missiles, directed energy weapons and an advanced short take-off, vertical landing (ASTOVL) (e.g., an AV-8B replacement).**	II	2-F 2-G 2-H
e. **Develop improved weapon and delivery systems to enhance the overall mobility, survivability and firepower of ground forces.**	III	2-G

13. UNDERSEA ENVIRONMENTAL ASSESSMENT	Quartile	CTI

Note: See appendix for classified requirements.

a. (Mid-term) Develop organic, high-resolution, fully functional   I
   oceanographic and meteorological models of the littoral region (e.g.,
   from the shelf break to the beach and including estuarine areas) that
   can assimilate multi-sensor data, are relocatable, may be coupled or
   nested, and are seamless at all boundaries between models.

b. (Mid-term) Develop global oceanographic and meteorological forecast   I
   models that are accurate out to X days and can be used with the littoral
   seas models (above) and with other higher resolution models of regional
   areas.

c. (Mid-term) Integrate the global atmospheric and ocean models (above)   I
   into a Defense Simulation Network, and then utilize the models for high
   fidelity simulations to aid in training and to develop improved sensors,
   weapons and platforms.

d. (Far-term) Improve the resolution of oceanographic and atmospheric   I
   analysis and forecasting models and provide these improved models to
   the ships for use in sensor and weapon system employment and as tools
   to help maintain battlespace dominance.

e. (Mid-term) Improve the scientific understanding of the environmental   II
   physics of the littoral environment to aid in:

   (1) The design of remote sensors, *in-situ* sensors and undersea weapons
   (2) Sensor and weapon prediction performance models
   (3) Non-acoustic methods of submarine and mine detection.

f. (Mid-term) Develop the capability to provide organic, high-resolution,   II
   fully functional oceanographic and meteorological analyses, or "now
   casts," of the littoral region.

g. (Mid-term) Provide an organic and deployable suite of sensors (possibly   II
   including UUVs) to sample the undersea environment in any given
   area, including a rapid survey for bathymetry and bottom analysis, and
   then communicate this *in-situ* oceanographic and atmospheric
   information to ships and primary production centers in real-time.

h. (Mid-term) Integrate national sensor systems into the Naval   II
   Meteorological Command (NAVMETOCCOM) process for
   environmental data collection and product construction, and
   communicate this collected data to all platforms.

i. (Far-term) Completely automate the fusion of all environmental data   II
   from various sources and transmit this to all ships and primary
   production centers. Improve data compression techniques and provide
   dedicated communication channels to ensure a rapid transmission to
   deployed forces.

j. **(Mid-term) Provide detailed environmental characterizations for the highest priority areas of regional conflict.** III

14. AIR CONTACT DETECTION	Quartile	CTI
a. **(Mid-term) Develop a battle group organic overhead sensor suite per the following specifications:** (1) Real-time downlinking of targeting quality data that is available to all ships on demand (2) Active aperture capability (3) Multi-function radar with a synthetic aperture radar/infrared synthetic aperture radar (SAR/ISAR) capability that is especially well suited for detection and targeting of low flying cruise missiles (4) IR capability optimized for TBM and cruise missile threat engagement cueing (5) Targeting quality data on inbound cruise missiles at greater than 50 nm (6) Theater-wide surveillance / tracking capability for ascent-phase TBMs.	I	2-C 2-D
b. **(Mid-term) Develop improved systems that provide a 3- to 4-fold increase in the detection ranges of high altitude cruise missiles, theater ballistic missiles (TBMs) and other air targets and provide the operator with discrimination, contact identification, and kill assessment.**	I	2-C 2-D
c. **(Mid-term) Develop systems that permit the automated correlation and integration of sensor information (from onboard and off board sensors described above) with intelligence data to provide a timely, unified tactical assessment of the situation.**	II	2-C
d. **(Far-term) Develop capability to provide to every ship and aircraft, in real-time, a continuously clear and accurate depiction of the location, status and intent of all contacts (threats, friendlies, neutrals) reported by a fully integrated and automated network of detection capabilities from all sources (incl. national, joint, theater organic, overhead organic and task group organic), per the following specifications:** (1) No horizon bounds (2) Precise location and identification of all targets (3) Current assessment status (including BDA when appropriate) (4) Integrated tipper information to warn of impending hostile action (5) Prevention against the accidental engagement of nonhostile forces.	II	2-C
e. **Develop improved systems that can reliably detect targets at longer ranges, in unfavorable environments, per the following specifications:**	II	2-C

(1) Signature characterizations of a target in all spectrums

(2) Unmanned, long endurance sensor platforms

(3) Ability to detect stealthy helicopters, UAVs and remotely piloted vehicles (RPV)

(4) Wide spectrum, shared aperture sensors

(5) Clutter and non-clutter real-time environmental measures (RTEM)

(6) Anti-jam (goal is jam-proof) sensors.

f. **(Mid-term) Develop a precision ESM capability per the following specifications:**   III   2-C

(1) At least 0.1-degree resolution in azimuth and elevation

(2) Pulse feature analysis and recognition

(3) Low probability of intercept (LPI) detection capability

(4) Simultaneously processing many signals in a high pulse environment.

g. **(Mid-term) Develop a beyond-horizon infrared search and track (IRST) capability with more than 10,000 pixels resolution, frame update rate above 100 Hz and possibly also including neural net processing.**   IV   2-C

h. **Pursue the development of new detection technologies, to include some of the following:**   IV   2-C

(1) Solid state, active aperture, multifunction radar

(2) High probability of intercept precision ESM

(3) Horizon IRST system

(4) Real-time, high-capacity datalink for force data sharing and engagement coordination

(5) Affordable T/R modules with adequate simultaneous bandwidth, power output, and efficiency

(6) Active antenna arrays that can perform multiple simultaneous beam operations via each array face

(7) Adaptive beam forming and control

(8) Photonic technologies

(9) High speed, high dynamic range A/D converters

(10) Affordable, light-weight, low-noise power supplies

(11) Reduced physical impact (space and support requirements).

15. SURVEILLANCE OF THE UNDERSEA BATTLESPACE	Quartile	CTI

Note: See appendix for classified requirements.

a. **(Mid-term) Establish the below-listed capability to surveil the undersea battlespace and thereby provide for unit self defense, control important sea lanes of communication (SLOCs), perform area clearance, and contribute to the development of the undersea common tactical picture.**   I   2-B
2-C

(1) Be able to perform the following given a coverage area of X square nm:
-          Search rate of ≥ X square nm/hr
- Coverage confidence ≥ X%
- Probability of detection ≥ X%
- Probability of true alert ≥ X%
- False alerts per hour ≤ X
- Reduce weight/volume of arrays by ≥ 50%
- Halve towed array's diameter while maintaining same level of self noise
- Reduce flow component of self noise on arrays
- Increase dynamic range of towed arrays to 22 bits
- Increase magnetic detection sweep width by a factor of 2
- Increase light detecting and ranging (LIDAR) depth to 3 attenuation lengths
- Demonstrate the capability to deny regional submarine operations.

b. (Far-term) Improve the above-stated capabilities to surveil the undersea battlespace as follows: I   **2-B** **2-C**

(1) Be able to perform the following given a coverage area of X square nm:
- Search rate of ≥ Y square nm/hr
- Coverage confidence ≥ Y%
- Probability of detection ≥ Y%
- Probability of true alert ≥ Y%
- False alerts per hour ≤ Y.

c. Develop improved underwater sensors as follows: I   **2-B**

(1) Develop sensors with better prime power sources and conversion technologies to more efficiently convert electrical energy into acoustic energy.
(2) Develop better passive sensors and improve array technology.
(3) Develop more capable non-acoustic sensors (e.g., electro-optical, electromagnetic and infrared).

d. Develop improved array handling mechanisms to permit more rapid deployment of the array and a capability for covert deployment of the array.   **II**

e. Develop improved computer processing capability as follows: **II**   **2-B**

(1) Improve the ability to detect, locate, classify, identify and track underwater contacts while reducing the rate of false alarms and bogus classifications.
(2) Improve data fusion and database management capabilities.
(3) Improve the handling of transients and intermittents, either false or from a real target.
(4) Improve LF and MF processing capabilities for bi-static (separate source and receiver) and multi-static (multiple sources and receivers) active prosecutions.

f. **(Far-term) Develop the capability to utilize advanced deployable** **III** **2-B**
systems, UUVs, submarines, ships and air assets to deny regional
submarine operations at will.

g. **Develop untethered, unmanned offboard surveillance platforms per the** **III**
following specifications:

    (1) Capable of covert launch and recovery
    (2) Capable of speeds $\geq$ 12 kts, also capable of reverse and hover
    (3) Endurance in excess of 72 hrs at 8 kts
    (4) Communications $\geq$ 20 kilo baud (kB)/sec without a wire
    (5) Navigation error $\geq$ X% of distance traveled
    (6) Positive ID capability.

16. OFFENSIVE MCM	Quartile	CTI
a. Develop the capability to conduct continuous area surveillance, provide immediate indications and warning (I&W) on a hostile's intentions, and maintain a current status of the hostile's platforms and minefield locations.	I	2-A
b. Based on the above surveillance, then develop the capability to determine the extent of the enemy mining threat, establish and maintain targeting quality location on the mining assets, and provide an early detection of any changes in readiness posture.	II	2-A

17. UNDERSEA FORCE/UNIT SURVIVABILITY	Quartile	CTI

Note: See appendix for classified requirements.

	Quartile	CTI
a. **Improve self-defense capability as follows:**	I	2-B 2-C
(1) Design improved threat detection and alert systems, improved and more automated classification techniques (including underwater IFF), and faster targeting systems. (2) Develop the capability for automated decoy release and a quick-response counterweapon launch. (3) Develop a robust anti-air capability for use against patrol aircraft. (4) Reduce ship and weapon acoustic signature.		
b. **(Mid-term) Improve own ship survivability through the use of distributed architectures, cooperative engagement techniques, improved platform maneuverability and responsiveness, ship and weapon signature control (acoustic & non-acoustic), and through improvements in platform-specific hull maintenance and electrical (HM&E) technology.**	II	2-B 2-C
c. **(Mid-term) Develop point defense systems capable of soft or hard kill against wake or acoustic homing torpedoes with a probability of soft or hard kill (P_k) ≥ X.**	II	2-B 2-C
d. **(Mid-term) Develop a shipboard organic capability for small object avoidance so that ships never close within X nm of an object (e.g., floating mine) whose size is between X and X cu ft.**	II	2-A
e. **(Mid-term) Establish the capability to perform an area denial mission as follows:**	IV	2-B

(1) Improved underwater sensor performance.

(2) Improve the ability to quickly identify threats and inbound weapons.

(3) Improve the ability to quickly assign a weapons system against an identified threat and then achieve a fire control solution.

(4) Improve underwater weapons systems by increasing weapon speed and endurance and decreasing weapon acoustics.

f. **(Far-term) Provide the capability to conduct area defense utilizing a sophisticated and automated detection, classification and warning system, with advanced countermeasures and self-defense weapons, that is capable of countering mixed salvoes of advanced weapons in a countermeasure rich littoral environment**   **IV**   **2-B**

18. UNDERSEA COVERT / NON-COVERT INDICATION & WARNING	Quartile	CTI

Note: See appendix for classified requirements.

a. **(Mid-term) Develop unmanned underwater vehicles (UUVs) equipped with electromagnetic, acoustic and electro-optical on-board and deployable sensor packages with the following intended goals:**   **I**

(1) Capable of covert and non-covert launch and recovery

(2) Capable of speeds $\geq$ X kts with reverse and hovering capability

(3) Endurance $\geq$ X hours at X kts

(4) Capable of communications $\geq$ X kB/sec without a wire

(5) Navigation error $\leq$ X% of distance traveled

(6) Capable of stealthful operation

(7) Positive ID capability.

b. **(Mid-term) Develop or improve the C^4I capabilities listed below:**   **II**   **2-F**

(1) Provide the capability for real-time covert communications between ships and submarines.

(2) Provide the capability for a ship to transmit and receive all sensed information (including data, voice/audio and optical/video) to or from higher authorities ashore using data rates that are compatible amongst all battle group assets and thus allowing for transmission and reception of the total tactical picture.

(3) Develop submarine towed/tethered body intercept antennas.

(4) Provide for ship connectivity with offboard sensors.

(5) Provide intelligence data to ground forces and to special operations forces (SOF).

(6) Transfer information from SOF commander to other battleforce units via SOCRATES (or other system).

(7) Conduct a two-way transfer of I&W information and intelligence data, including imagery, via a secure, high data-rate circuit.

(8) Provide ESM systems with extended frequency coverage.

(9) Improve signals intelligence processing to support complex modulation schemes, encryption schemes and language translation.

(10) Improve automated identification methods and systems to counter proliferation of emitters and cellular technology.

(11) Interface intelligence data collecting systems directly with combat control systems to improve contact correlation amongst sensors.

(12) Incorporate nonorganic sensor data into a ship's ESM system for cueing, contact correlation and ambiguity resolution.

c. (Far-term) Further develop or improve the C^{4}I capabilities listed below: II   2-F

(1) Provide the capability for every ship to directly downlink from non-organic intelligence sensors.

(2) Provide capability for platforms to receive full-motion video from in-place ground forces and from SOF.

(3) Enhance data throughput by designing communications paths with higher data rates.

d. (Mid-term) Develop the following improvements in imaging capability: II   2-F

(1) Provide a high-resolution capability for multi-band IR imaging.

(2) Provide an around-the-clock imaging capability that is unaffected by weather conditions.

(3) Reexamine communications link, bandwidth and cryptological requirements to permit imagery sharing between all ships, ground forces and SOF.

e. (Mid-term) Develop or improve the SOF capabilities listed below: III   2-F

(1) Improve the capability of designated ships to host SOF units, particularly in its ability to rapidly transit to the egress location while improving readiness and logistics support for SOF.

(2) Provide the capability to covertly communicate with SOF units from a host submarine throughout the period from egress to recovery.

(3) Improve SOF sensors to covertly image in any environment (e.g., dark and turbid waters, surf zone, etc.).

(4) Control SOF equipment signatures to be compatible with mission requirements (e.g., no or low magnetic signature in proximity of minefield).

(5) Control swimmer delivery vehicle (SDV) signatures to be equivalent to or less than the host platform's as a means to prevent counterdetection.

f. (Far-term) Improve SDV technology to increase insertion range by a
    factor of two over current capabilities; involved in this is the related
    requirement for improvements in SDV life support systems.   III   2-F

g. (Far-term) Establish the capability to communicate across the spectrum   III   2-F
    in real time between SOF units, submarines and ships without
    operational limitation.

h. (Mid-term) Utilize low observable (LO) technology in shipbuilding by   III   2A
    making the following reductions in acoustic, electromagnetic and   2-F
    electro-optical signature.
    (1) Employ LO technology in the design of sails, rudder, masts, antennas
        and exposed decks for SSNs that engage in SOF operations.
    (2) Employ LO technology in the design of surface ship superstructures.

    (3) Reduce the acoustic signatures of surface ships, submarines, UUVs and
        SDVs to reduce the probability for counterdetection.
    (4) Establish the low probability of intercept (LPI) mode of communicating
        as routine.

19. KNOWLEDGE OF OWN FORCES	Quartile	CTI

a. (Mid-term) Develop systems that provide precise location information   I
    on all theater U.S. and allied forces on the sea, on land or in the air
    (thereby permitting less restrictive ROE due to a thorough knowledge
    of all friendly and other forces and pertinent and timely warning of
    hostile intent).

b. (Mid-term) Improve the security of the GPS to protect against enemy   II
    spoofing and to deny its use to the enemy altogether.

c. (Far-term) Pursue the following technology initiatives: II
    (1) Increased datalink throughput
    (2) Secure, LPI communications
    (3) Combined IFF and datalinks
    (4) Real-time tactical display in the cockpit.

20. SPECIAL & UNCONVENTIONAL OPERATIONS	Quartile	CTI

a. Ensure all Navy systems are fully interoperable with Army and Air   IV
    Force systems and with the systems of those services' special operations
    forces (SOF).

b. Develop improved and more streamlined procurement and fielding   IV
    procedures to deliver the best equipment in the least amount of time.

c. Develop new systems with multi-scenario adaptability/flexibility and   IV   2-F
    with improved reliability in the field.

d. Ensure SOF requirements are incorporated into the design of future   IV
    Naval platforms.

21. MINE WARFARE COUNTER-COUNTERMEASURES	Quartile	CTI
*** No data. ***	N/A	

22. ENVIRONMENTAL PHYSICS OF MINE WARFARE	Quartile	CTI

a. Develop the capability to perform the following real-time, *in situ*   III   2-A
    environmental monitoring and analysis of the natural forces that act
    upon mines while they are deployed:
    (1) Monitor and measure relevant *in-situ* geophysical, magnetic, optical,
        oceanographic, hydrographic and meteorological parameters.
    (2) Link this data in real-time with historical databases of related data.
    (3) Provide instantaneous analysis in an understandable format to the MCM
        task force commander and other local or remote users.

b. Develop a more complete understanding of the physics involved in   III   2-A
    monitoring the environmental parameters associated with MCM and in
    the physics associated with sensor vs. mine vs. environment
    interactions, effects on performance and overall system effectiveness.

23. WEAPONS AGAINST OTHER MARITIME SURFACE TARGETS	Quartile	CTI

a. Develop C^4I systems to support improvements in over-the-horizon   II   2-I
    (OTH) targeting, battlefield surveillance, target identification and battle
    damage assessment (BDA), with emphasis on the following:

    (1) More precise localization of the target.
    (2) Reduced timelag of data (e.g., seconds rather than minutes).
    (3) Ability to support higher velocity weapons.
    (4) Low-cost solutions to the above improvements.

b. Establish the capability to target selectivity in all weather conditions;   III   2-I
    specifically, to pick the right target among friendlies, neutrals and other
    distractions (such as oil derricks, countermeasures, etc.).

c. Develop improvements to weapons systems and launching systems.   IV   2-G
    (1) Develop precision guided munitions (PGM) that support autonomous
        target recognition.
    (2) Improve propulsion systems to result in higher speeds and longer ranges.
    (3) Design and produce more variants of submunitions, including warheads
        with greater penetrating capability.
    (4) Design conventional munitions with a man-in-the-loop terminal
        guidance capability.

d. **Develop systems to support a reduced response time between target detection and identification to target engagement and kill (e.g., a response time of minutes rather than hours).**   IV

24. AIR BATTLESPACE SURVIVABILITY	Quartile	CTI

a. **(Mid-term) Reduce an aircraft's susceptibility to weapon targeting, by ships or by other aircraft, through the use of signature reduction technologies and other techniques, including:**   II

    (1) Integrated mission effectiveness analyses whereby realistic battlefield environments are simulated during system development.

    (2) Improved defensive and evasive tactics development.

    (3) Use digital models of signature and countermeasure technologies.

b. **(Mid-term) Reduce an aircraft's vulnerability to air- or ship-launched weapon impact through the use of various technologies, possibly including:**   III

    (1) Man-portable missile defense and/or suppression.

    (2) Propulsion system vulnerability reduction.

    (3) Engine bay fire protection.

    (4) Fire suppression and extinguishing agents.

    (5) Detection, mitigation and protection from fires in onboard stores.

    (6) Self sealing integral fuel tanks.

    (7) Adaptable active damage control systems.

c. **(Mid-term) Reduce a ship's vulnerability to weapon impact through the use of various technologies, possibly including:**   IV   2-A

    (1) Redundancy and separation of critical functions.

    (2) Improved personnel protection.

    (3) Improved internal communication and information management.

    (4) Improved firefighting systems.

    (5) Improved emergency escape breathing devices.

    (6) Longer lasting oxygen breathing apparatus.

    (7) Integrated survivability management system

    (8) Graphic display of damage areas.

    (9) Damage containment decision aids.

    (11) Blast resistant decks and bulkheads

    (12) Damage resistant construction materials and coatings

    (13) Lightweight armor

    (14) Active armor (absorbs energy of the blast).

d. **(Far-term) Further reduce an aircraft's vulnerability to weapon impact through the use of various technologies, including possibly:**   IV

(1) Advanced engine bearing technology
(2) Laser hardening
(3) Munitions designed for survivability.

25. AIRCRAFT PLATFORMS & PROPULSION	Quartile	CTI
a. **(Mid-term) Improve the technology for ASTOVL lift and propulsion in preparation for the AV-8 and F/A-18C replacement acquisition programs. Also, examine a vertical or short take off and landing capability for unmanned vehicles.**	**II**	
b. **(Mid-term) Pursue improvements in component reliability as a method to reduce overall life-cycle costs.**	**II**	
c. **(Mid-term) Increase the use of lightweight structures as a method to improve performance while potentially reducing fuel costs.**	**III**	
d. **(Far-term) Incorporate low observable (stealth) technologies into all future airframe designs as a survivability issue.**	**III**	
e. **Design advance avionics using new technologies to provide the following improvement in capabilities:**	**III**	

(1) (Mid-term) Positive identification in all aspects, day or night, to allow weapons employment at maximum range.

(2) (Mid-term) Inflight mission reprogramming to allow targeting of time critical targets.

(3) (Mid-term) Near-real-time bomb/battle damage analysis (BDA).

(4) (Mid-term) Adaptive self-protection electronic countermeasures to activate when required in direct response to threat waveforms.

(5) (Mid-term) Improved antennas that increase performance and reduce size requirements, possibly including shared aperture technology to reduce the number of antennas on an airframe.

(6) (Far-term) Multi-platform and multi-sensor data fusion and integration to provide real-time intelligence and targeting to the cockpit (while avoiding display clutter and information overload).

(7) (Far-term) Improved cueing to the pilot including off-boresight acquisition capability (via helmet-mounted sight).

f. **(Far-term) Continue ongoing propulsion research to improve the specific energy of aviation propulsion fuels, possibly to include non-fossil fuels, and provide propulsion superiority for U.S. aircraft.**	**III**	
g. **Pursue a joint service common design (of at least 80%) in the programs to replace the F-14 and F/A-18E/F.**	**IV**	

26. REMOTE CONTROL OF MINEFIELDS	Quartile	CTI
a. (Far-term) Develop the ability to perform remote command and control of individual mines in shallow littoral environments.	III	2-D

27. MINE DELIVERY	Quartile	CTI
a. (Mid-term) Develop the capability to deploy a littoral sea minefield from aircraft and/or submarines that is capable of detecting and immobilizing quiet diesel submarines, surface warships and high-speed surface craft operating in water as deep as 500 feet.	II	2-A
b. (Far-term) Develop the ability to deliver high volumes of all types of mines from aircraft and/or submarines.	II	2-A
c. (Mid-term) Develop the capability to deploy a littoral sea minefield from surface ships that is capable of detecting and immobilizing quiet diesel submarines, surface warships and high-speed surface craft operating in water as deep as 500 feet.	IV	2-A
d. (Far-term) Develop the ability to deliver high volumes of all types of mines from surface ships.	IV	2-A

28. AIRCRAFT EXTERNAL & INTERNAL COMMUNICATIONS	Quartile	CTI
a. Develop more flexible aircraft communications equipment and communications paths that support automatic reconfiguration to meet a given tactical requirement.	II	
b. Develop aircraft communications systems with improved voice clarity in secure mode.	III	
c. Develop improved aircraft communications systems that incorporate an automatic language translator.	IV	

29. MARITIME INTERDICTION (OF MERCHANT SHIPPING)	Quartile	CTI
a. Develop improved surveillance systems that support detection, classification and covert tracking of merchant ships per the following specifications: (1) (Mid-term) Over-the-horizon (OTH) detection, tracking and signature cataloging of suspect merchant ships. (2) (Far-term) Wide-area detection, tracking and signature cataloging of all merchant ships, probably by satellite surveillance.	II	2-I
b. Develop new non-lethal antiship weapons for use against merchant ships per the following specifications:	II	2-I

(1) (Mid-term) Weapons that can stop a merchant ship with minimal damage to its structure at a range of up to 500 yards and with an accuracy of better than 5 m.

(2) (Far-term) Weapons that can stop a merchant ship without casualties and with no damage to its structure at a range of up to 1000 yards and with an accuracy of better than 1 m.

c. **Develop hand-held sensors for use in inspecting the cargo of a boarded merchant ship per the following specifications:** III 2-I

(1) (Mid-term) Sensors that can be used on board a merchant ship to detect drugs, munitions or weapons anywhere on the ship (including in cargo the holds or attached to the ship's external or internal hull).

(2) (Far-term) Sensors that can be use remotely, prior to boarding, to detect drugs, munitions, weapons or people anywhere on the ship (including in the cargo holds or attached to the ship's external or internal hull).

d. **Develop equipment and/or procedures to permit the boarding of merchant ships per the following specifications:** III 2-I
(1) (Mid-term) In sea states up to state 3.
(2) (Far-term) In any sea states in the daytime or at night.

e. **Develop an improved capability to covertly detect and tag merchant ships and correlate the tracking of such ships using air, surface, submarine and satellite assets.** IV 2-I

30. MINE EFFECTIVENESS	Quartile	CTI
--- No data.---	N/A	

31. ASSESSING BATTLE DAMAGE	Quartile	CTI
a. **Improve aircraft sensors and datalinks to provide real-time delivery of BDA data for hard kill attacks against weapons of mass destruction (e.g., theater ballistic missiles) immediately following a first attack in order to determine the need for second and subsequent attacks.**	II	
b. **Improve aircraft sensors and datalinks to provide real-time delivery of BDA data for soft or hard kill against other weapons or platforms (e.g., cruise missiles, aircraft) immediately following a first attack in order to determine the need for second and subsequent attacks.**	III	
c. **Improve aircraft sensors and datalinks to permit better conservation of sensor resources; specifically, to perform BDA without affecting the aircraft's weapons capability (e.g., without tying up weapons directors) and to perform BDA without being affected by flak or debris (e.g., without taking longer to assess BDA due to detection of chaff, aircraft remains, etc.).**	III	

d. In concert with above improvements, also provide the ability to determine if a target is carrying weapons of mass destruction prior to engaging.   III   2-C

32. AIRCRAFT SUSTAINABILITY	Quartile	CTI
a. Establish the capability for condition-based maintenance of aircraft, possibly using diagnostic systems, automated tools and datalinks.	II	
b. Improve aircraft endurance by improving the potency of propulsion fuels.	III	
c. Improve weapons delivery capability by increasing magazine capacities.	III	

33. CONTROL OF AIRCRAFT SENSORS AND WEAPONS	Quartile	CTI

a. **(Mid-term) Create highly efficient display(s) and automated controls that allow commanders to quickly assimilate the tactical situation, respond to the situation by sensor/weapon control either by doctrine or machine learning, immediately negate automatic action if required, immediately initiate action as required, and maintain manual control whenever the situation warrants.** — IV

b. **(Mid-term) Design automatic "experts" as tactical aids that support the automatic employment of weapons and provide an as-soon-as-possible reaction time while enabling correct, flexible decision making and control of weapons.** — IV

c. **(Mid-term) Design automatically reconfigurable systems; e.g., systems that automatically repair themselves or automatically reroute themselves in the event of degraded performance or partial system failure.** — IV

d. **(Mid-term) Design automated sensor management and cross-system integration for fully automated situational assessment and optimum performance of entire system set.** — IV

e. **(Mid-term) Fully open architecture for ease of systems integration, interoperability, modifications, and improvements.** — IV

f. **(Far-term) Design a fully automated combat system that is smart, automatically adaptive, damage resistant, centrally controlled and requires minimal operator action.** — IV

g. **(Far-term) Design aircraft avionics with a virtual reality interface and the capability to "learn" from the operator.** — IV

34. MINEFIELD PLANNING***	Quartile	CTI

a. **Develop tactical decision aids (TDAs) to support MIW mission planning and related MIW training as follows:** — IV — 2.D

(1) Given a particular reconnaissance/surveillance system's historic level of performance and the level of mining activity it reports, a related TDA should be able to accurately predict a minefield's boundaries, the mine content within those boundaries, the risk to traffic and the likelihood of success for a given MCM mission.

(2) Given a range of tactical situations, an MIW interdiction TDA should be able to define optimal minefield boundaries as well as the mine density, configuration and settings needed to achieve a commander's goals.

(3) MIW engagement TDA should accurately predict interrelationships of mining intelligence, mine laying and clearing activities, area reconnaissance and naval operations against suspected/known/ unknown minefields, and then predict the likelihood of mission success in various timeframes and also accurately predict the mine risk or probability of safe transit to the tactical commander.

(4) An inter-warfare coordination and strike TDA should be able to:
- Correlate and fuse data from all sources (i.e., ASW, Strike)
- Develop mine danger areas, ship transit routes, etc.
- Disseminate risk information to all concerned.

35. MINE TRAINING SYSTEMS	Quartile	CTI
*** No data other than what appears in Item 34.	IV	

36. MINE WARFARE TRAINING SYSTEMS	Quartile	CTI
*** No data other than what appears in Item 34.	IV	

Chapter 3

Joint Surveillance

Strategic vision: Provide systematic observations of the battlespace with timely and accurate reporting of information required by the joint warfighting commander to support domination of the battlespace.

Definition and Scope

Joint Surveillance is the collection and categorization of target information in all warfare areas. It provides systematic observations of the battlespace, with timely and accurate reporting of the information to the joint warfighting commander. Successful surveillance supports domination of the battlespace. It ranges from the response to exo-atmospheric detection of theater ballistic missiles, through the intercept of enemy signals intercepts, to the detection of buried mines as part of a mine-sweeping operation. While diverse, the general precepts of each surveillance problem are built on the same fundamentals: (1) complete detection; (2) extensive tracking; (3) melding of local and force information to provide classification and identification information; (4) automatic notification of changes; and then (5) designation to a war-fighting system. Relative to any war-fighting approach, good surveillance is paramount.

Functional Description

The objectives of this technology area are to optimize performance and minimize costs of DoN systems. This area encompasses six basic thrusts: (1) improvement in tactical reconnaissance (e.g., situational awareness); (2) identification and tracking improvements for mobile targets; (3) surveillance improvements for mine warfare; (4) information availability and compatibility for C^4I; (5) surveillance resource management; and (6) actions taken to make the best use of the environment. These areas are described below.

Tactical reconnaissance (situational awareness) considers the integration of intelligence information with surveillance. It leads to systems that use intelligence to cue sensors for detection. Once detected, the tactical reconnaissance mission collects all available information for the identification task and then provides automated notification to operators of any changes.

Mobile targets considers actions to detect and track moveable land- and sea-based targets that have been very difficult to track before. Thanks to microelectronics, nearly any adversary will be able to employ these weapons against US forces. Since they often require tracing across a land-

sea interface, this area has always been a low priority. Recent experience has shown both the difficulty of the problem and the necessity for solutions.

While *mine* warfare has never been considered an important surveillance mission, the detection and classification of deployed and buried mines is actually one of the most difficult tasks. The translation of successful techniques from other surveillance areas to this warfare area may simplify this difficult warfare area. This area also considers the effects of the warfare area in a broader perspective. It includes covert operations to sweep channels and surveillance techniques that will be used to verify that previously swept channels are still safe for transit.

Information availability/compatibility with C^4I describes approaches to meld sensor information into a coherent track picture using a variety of sensors and platforms. It includes non-traditional sensor enhancement, such as the use of frequency domain sensing techniques for autonomous target recognition as well as greater use and dissemination of imagery.

Surveillance Resource Management describes techniques to coherently meld sensor information for a battle force. It includes techniques to deconflict sensor reports, striving for (1) one-track-for-one-target throughout the surveillance zone and (2) integration of intelligence into this area to maximize detection ranges.

Environment (surface/subsurface/air) considers techniques to make better use of all sensors regardless of the environment. While it is not possible to change the environment, it is possible to optimize sensors to achieve the best performance possible. This area also includes actions to deny environmental sanctuaries to an enemy.

Requirements

Underlying the strategic vision for Joint Surveillance are five top-level warfighting functional requirements, prioritized as follows:

1. **TACTICAL RECONNAISSANCE (SITUATIONAL AWARENESS)**
2. **MOBILE TARGETS**
3. **MINES**
4. **INFORMATION AVAILABILITY/COMPATIBILITY WITH C^4I**
5. **SURVEILLANCE RESOURCE MANAGEMENT**

Table 3 lists prioritized goals and objectives under each of the five top-level warfighting functions. These goals and objectives represent S&T requirements for Joint Surveillance. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Joint Surveillance-related paragraphs in the CTIs, published verbatim in Appendix 3. For reference, Appendix 3 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 3. JOINT SURVEILLANCE: PRIORITIZED S&T REQUIREMENTS		

1. TACTICAL RECONNAISSANCE (SITUATIONAL AWARENESS)	**Quartile**	**CTI**
a. Implement real-time indication and warning (I&W) methods into combat operations.	I	**3-A, 3-B**
(1) Develop long-range detection of all enemy craft.		
(2) Provide comprehensive methods for positive hostile IDs.		
(3) Separate real targets from decoys.		
(4) Develop techniques to detect the deployment of chem/bio compounds.		
b. Provide real-time (or near real-time) battle damage assessments.	I	**3-B**
c. Improve targeting methods in all warfare areas.	II	**3-A, 3-B**
(1) Implement Combat ID techniques.		
(2) Provide advanced OTH targeting techniques into deployed systems.		
(3) Geolocate.		
d. Perform comprehensive intelligence preparation of the battlespace.	II	**3-A, 3-B**
(1) Develop techniques for unobtrusive sensing.		
(2) Develop techniques to meld information into a common frame of reference for analysis.		
e. Characterize the surface, subsurface and air environments.	III	**3-D**
(1) Determine environmental, jamming and electromagnetic field interference (EFI) effects on battlespace sensor operations in real time.		
(2) Develop techniques to characterize the battlespace environment; e.g.:		
(a) Remote-sensing techniques.		
(b) Wide-area data collection and processing to determine significant parameters that effect operations.		
(c) Covert techniques to assess sensor performance.		
(3) Develop sensors that eliminate enemy use of potential environmental sanctuaries.		

2. MOBILE TARGETS	**Quartile**	**CTI**
a. Develop theater-wide techniques to detect targets.	I	**3-B 3-C**
(1) Implement tracking algorithms that provide "weapons-quality" data.		
(a) Develop methods to tag targets with earned information.		
(b) Prioritize and maintain tracks.		
b. Develop automatic classification (what) and identification (whose) systems.	I	**3-B 3-C**

c. Research and implement automated change doctrine that identifies changes, evaluates them, and then notifies end users if necessary.   III

d. Create techniques to recognize deception attempts and perform counterdeception.   III

e. Characterize the surface, subsurface and air environments.   III   3-D
    (1) Determine environmental, jamming and EFI effects on battlespace sensor operations in real time.
    (2) Develop techniques to characterize the battlespace environment; e.g.:
        (a) Remote-sensing techniques.
        (b) Wide-area data collection and processing to determine significant parameters that effect operations.
        (c) Covert techniques to assess sensor performance.
    (3) Develop sensors that eliminate enemy use of potential environmental sanctuaries.

3. MINES	Quartile	CTI
a. Develop improved techniques to monitor areas.	I	3-B
b. Improve covert operations.	II	3-B
(1) Support covert, multi-platform detection of Q-routes.		
(2) Support covert, multi-platform wide area detection.		
c. Develop improved techniques to identify mine type	II	
d. Implement advanced techniques for the deployment, storage, transport and preparation of mines for combat action.	II	
e. Improve methods to perform in-situ mine detection and classification.	III	3-B
(1) Implement timely detection, classification, and location of mines at 30 feet of water depths and to the shore.		
(2) Improve techniques to detect buried mines.		
(3) Build methods to detect near-surface mines at any water depth.		

4. INFORMATION AVAILABILITY/COMPATIBILITY WITH C^{4}I	Quartile	CTI
a. Improve the timelines of information collection and preprocessing.	I	3-A 3-B
b. Improve the accuracy of information collection and preprocessing.	II	3-A 3-B
c. Improve/enhance sensor preprocessing.	II	3-A 3-B
(1) Provide for timely transmission of information to the initial user.		
(2) Provide increased imagery throughput.		
d. Improve the completeness of information.	III	3-A 3-B

5. SURVEILLANCE RESOURCE MANAGEMENT	Quartile	CTI
a. Develop real-time sensor optimization and display systems	**III**	**3-A**
(1) Coverage includes blue on red, red on blue, and third parties.		**3-B**
(2) Optimize resource utilization.		
b. Automatically allocate sensors (and then weapons) to targets.	**III**	**3-B**
c. Develop improved methods for sensor data deconfliction	**IV**	**3-C**
d. Develop improved methods for BDA data management.	**IV**	**3-A**
(1) Provide capability to overlay sensor data.		**3-B**
e. Develop systems to automatically provide vulnerability alert.	**IV**	
(1) Develop a TDA for real-time optimization of sensor utilization.		
(2) Develop an enabling C2 for timely tasking/retasking of theater and national assets by tactical commanders; automate the process.		
f. Automate BDA.	**IV**	**3-A**
		3-B
g. Develop improved methods to catalog available resources, capabilities and joint assets to benefit joint forces.	**IV**	

Chapter 4

Joint Space and Electronic Warfare / Intelligence

Strategic vision: Battlespace dominance through the availability and use of the right information at the right place and at the right time, and denial of the same to the enemy.

Definition and Scope

Joint Space and Electronic Warfare (SEW) is the destruction, control or neutralization of targets through integrated employment of command, control, communications, computers and intelligence systems (C^4I) and command and control warfare (C^2W). It includes enhancement of battle management through integrated exploitation of the electromagnetic spectrum and space. Intelligence is the collection, processing, integration, analysis, evaluation and interpretation of available information concerning foreign areas.

Functional Description

C^4I encompasses elements that permit forces to act in concert to achieve their objectives, including the following:
- Measures to coordinate, correlate, fuse and employ aggregate capabilities in communications, surveillance, reconnaissance, data correlation, classification, targeting and electromagnetic attack.
- Measures to direct and control employment of friendly forces.
- Systems and methods required for the transmission, processing and storage of friendly-force, enemy and environmental data for use in a joint-warfare engagement.
- C^4 support.

C^2W targets adversaries' C^2 structure to deter them from taking aggressive action or to lead to earlier capitulation. It includes the following:
- Measures to deny, deceive, disrupt, destroy or exploit the enemy's capability to communicate, surveil, reconnoiter, classify, target and attack.
- Integrated use of operations security, military deception, psychological operations, electronic warfare, and physical destruction--mutually supported by intelligence--to deny information

to, to influence, to degrade or to destroy adversary C^2 capabilities while protecting friendly capabilities against such actions.

Requirements

Underlying the strategic vision for space and electronic warfare/intelligence are six top-level warfighting functional requirements, prioritized as follows:

1. **COMMON TACTICAL PICTURE.**
2. **BATTLE MANAGEMENT.**
3. **CONNECTIVITY.**
4. **COUNTER C^2 / C^2 PROTECTION.**
5. **C^2W PLANNING AND ANALYSIS.**
6. **ENABLERS.**

Table 4 lists prioritized goals and objectives under each of the six top-level warfighting functions. These goals and objectives represent S&T requirements for Joint Space and Electronic Warfare / Intelligence. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Joint SEW/I-related paragraphs in the CTIs, published verbatim in Appendix 4. For reference, Appendix 4 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

Note: In Table 4, measures of effectiveness include the following: no unintended damage or losses, no engagement delay due to ID/classification, and completeness of ID/classification within the battlespace picture. Measures of performance include timeliness/range coverage (complete within weapons space), confidence in ID decisions, false decision rate, security/protection cost/size/portability.

TABLE 4. JOINT SEW / I: PRIORITIZED S&T REQUIREMENTS

1. COMMON TACTICAL PICTURE	Quartile	CTI
a. Produce a common tactical picture for all users.	I	**4-A**

   (1) Must be timely (real-time vs. historical).
   (2) Must provide a consistent, relevant and scaleable overview to the user.
   (3) Must have a level of confidence attached to the data which conveys the degree of timeless, latency and accuracy.
   (4) Must allow for quality of image required for the type of data being displayed (variable).

	Quartile	CTI
b. Produce a display functionality that is automatically configurable to the user's (warfighter's) needs with minimum man-machine interface.	I	**4-A**

   (1) System must be capable of providing automatic correlation / data fusion or organic and nonorganic information.
   (2) System must provide for management, storage, retrieval and dissemination of relevant contact data for timely, optimized and prioritized data display.
   (3) Man-machine interface must minimize human interaction in order to produce an optimized display for the tactical situation.

	Quartile	CTI
c. Ready access to required information (databases and sources) to support any mission objective.	I	**4-A** **4-B** **4-H**

   (1) Establish a data highway for access to all sources of information.
      (a) National (mapping, charting, and geodesy (MC&G); meteorological and oceanographic (METOC); non-traditional, non-combatant sources; joint intelligence; national sensors).
      (b) Tactical (organic sensors - unit/force/theater).
      (c) Readiness (Plans, status, and capability).
      (d) Allied/coalition.
   (2) Establish recognized repositories/databases.
      (a) National (MC&G; METOC; non-traditional, non-combatant sources; joint intelligence; and national sensors).
      (b) Tactical (organic sensors - unit/force/theater).
      (c) Readiness (plans, status, and capability).
      (d) Allied/coalition

d. Provide controlled access to required information geared to user   **I**   **4-A**
     security level and needs.   **4-B**
     (1) System must provide for multi-level security.
     (2) Security levels must address access by:
         (a) Joint multi-level.
         (b) Allied/coalition.

e. No fratricide or collateral damage.   **I**

f. Weapons release in time to destroy targets effectively and efficiently   **I**

g. Situational awareness / understanding of battlespace.   **I**
     (1) Provide capability for timely and correct ID of:
         (a) Aircraft.
         (b) Missiles (cruise, ballistic, etc.).
         (c) Ships.
         (d) Boats.
         (e) Submarines
         (f) Mines
         (g) Troops on shore.
         (h) Land vehicles and fixed sites.
     (2) Provide automated ID in high density & time critical situations.
         (a) for critical response time
         (b) to keep overall picture current
         (c) to avoid errors of human stress
     (3) Integrate all available high-confidence sources into ID decisions.
         (a) Precision track, location, and trajectory
         (b) Origin and route.
         (c) Emissions (including visual).
         (d) Other sources.
     (4) Automatically integrate rules of engagement into ID decisions.
     (5) Determine threat intent using all-source information.
     (6) Enable troops to distinguish friendly & hostile contacts.
         (a) Positive friendly ID device or method.
         (b) Protected against hostile use.
         (c) Protected against exploitation.
         (d) Available to all.
     (7) ID the type and characteristics of attacking weapons:
         (a) To understand the threat.
         (b) To support targeting decisions.
     (8) Disseminate friendly and hostile ID with precise location and in time
         to support targeting systems.

h. Improved GPS accuracy   I

    (1) Improved (precision timing/timing-interval) PTTI capabilities and precise satellite location capabilities (astrometry/orbital mechanics) directly contribute to improved GPS accuracy.

i. Improved MC&G data collection capabilities with shrinking resources.   I   **4-H**

    (1) Transition to multi-purpose ship operations (coastal, bathymetric, hydrographic, oceanographic) to maximize data collection with fewer assets.

    (2) LABS laser airborne bathymetry provides rapid shallow water survey capability.

    (3) Dolphins remotely operated vehicle (ROV) development for surveyors significantly increase survey ship data coverage.

j. Contribute to navigational safety.   I   **4-A**
                                                                       4-I

    (1) Continue priority emphasis on in situ optimum track routing for ships and aircraft capabilities to provide viable weather avoidance recommendations.

    (2) Maintain programs in PTTI and astrometry supporting space operations, C^4I, weapon guidance systems and improved precise navigation, both earth and space based.

k. Develop GPS independent navigation alternatives.   I   **4-B**

l. Tasking: Improve collection management process to increase   I   **4-C**
accessibility and responsiveness.

    (1) Provide better connectivity and feedback from collection management system through brokering agency/organization.

    (2) Explore long-term storage and indexing as means to mitigate collector tasking by providing extant information.

    (3) Provide current status of active taskers to all customers.

m. All-source integration: Ensure that all available intelligence products I   **4-A**
are fused with optimum timeliness and accuracy through improved   **4-B**
processing, analysis, evaluation, correlation, and validation.

    (1) Enable seamless incorporation of METOC, MC&G, propagation, etc.

    (2) Enable open source exploitation (e.g. unclass. sources, INTERNET).

    (3) Provide consumer with a timely, continuous (but manageable) flow of information.

    (4) Designate single fusion point location for quality control.

n. Architecture for dissemination: Ensure timely availability of the   I   **4-A**
information the consumer requires.   **4-D**

(1) Develop automated sanitization processing of intelligence to expand accessibility to customers.

(2) Provide for continuous feedback from consumers via two-way, vertical/horizontal information flow.

(3) Ensure products are tailored to specific consumer requirements, and improve dissemination efficiency through technical means (e.g. compression) and elimination of unwanted duplication.

(4) Develop techniques to maintain accuracy of data bases during data fill through automated discrepancy flagging, automated validation, and automated identification of potential discrepancies.

(5) Provide a universal standardized format for imagery dissemination.

(6) Provide deploying units with appropriate and robust imagery data base, with capability to update the data base via routine automated incorporation of the deltas.

o. Display: Provide a display function common among consumers and   I   **4-A**
analysts which is configurable to their needs.   **4-B**

(1) Provide display at resolution quality sufficient for consumer needs.   **4-D**

(2) Provide capability to accept and display data from diverse sources (e.g. imagery, multimedia, video, gun camera, forward looking infrared (FLIR), text, DMA mapping, METOC, MC&G etc.).

(3) Provide display techniques to support mission planning and rehearsal.

(4) Provide display manipulation capability to support/augment info (e.g. annotation, overlays, scene manipulation / perspective view).

p. Data Processing: Develop tools to allow the analyst to   I   **4-A**
access/manipulate/analyze data more efficiently.   **4-B**

(1) Develop capability to retrieve data for fast browsing of data.

(2) Provide automated capability to recognize target / signal of interest.

(3) Provide automated capability to detect/flag changes in area of interest.

q. Provide 3-D, high resolution (analysis & forecast parameters)   I   **4-A**
METOC depiction of the battlespace.   **4-B**
     4-I

r. Improve critical assessment of littoral tactical situations.   I   **4-A**
     4-H

2. BATTLE MANAGEMENT	Quartile	CTI

a. Develop mission planning systems which are simple and easy to use,   I   **4-A**
   traceable to commander's requirements, doctrinally correct, and   **4-B**
   provide for concurrent planning at all levels.   **4-C**
   (1) (Mid-term) All levels share a common planning core in a common   **4-F**
       operating environment.
   (2) (Mid-term) Sufficient independence of operation environment to
       permit easy migration to other environments as technology advances.
   (3) (Far-term) Automatic update (< 2 hrs) of plans to/from next level
       up/down (mid-term). Real time, concurrent update to/from next level.
   (4) Define littoral battlespace in terms of meteorological / oceanographic /
       MC&G parameters.

b. Provide execution aids which are survivable, reduce the fog of war,   I   **4-A**
   and are fully integrated with their intended environment.   **4-D**
   (1) (Mid-term) Adaptive output including multimedia to attract immediate   **4-H**
       attention of users when necessary but not distracting to the user.
   (2) (Mid-term) Real time dissemination of time-critical orders.
   (3) (Far-term) Automatic display of consequences (e.g. affected elements
       of the battle plan) by changing commander's intentions or ROE.
   (4) (Far-term) Horizontally and vertically concurrent in real time.
   (5) (Far-term) Prioritization of actions or decisions required.
   (6) Be able to redirect or deploy METOC and MC&G resources including
       numerical computing and environmental satellite reception
       capabilities in support of crisis operations.

c. Provide accurate, real time assessment of the effects of actions in a   I   **4-A**
   battle/crisis management situation.   **4-B**
   (1) (Mid-term) Dedicated resources for near real time BDA; (far-term)
       organic, real time BDA.
   (2) (Mid-term) Computer assisted lessons learned; (far-term) fully
       automated lessons learned (far-term).
   (3) (Far-term) Automatic BDA information fusion and prioritizing.

d. Provide real time, concurrent update, control, processing, fusion and   I   **4-A**
   dissemination of Battle/Crisis management information.   **4-B**
   (1) (Mid-term) Prioritize information based on accuracy and urgency with   **4-C**
       operator assistance; (far-term) prioritize information accuracy and
       urgency automatically.
   (2) (Mid-term) Translate text among several foreign languages; (far-term)
       translate text among most foreign languages and alphabets.
   (3) (Far-term) Concurrent update, access control, and dissemination.

**e. Provide decision aids which enable the decision maker to focus quickly   II
   and clearly on the decisions required, identify critical information,
   and provide the expected outcome of alternative choices.**
   (1) (Mid-term) Computer assisted selection / prioritization of critical
        information. (Far-term) Fully automated selection / prioritization of
        critical information .
   (2) (Far-term) Estimated outcome of a particular selected course of action.
   (3) (Mid-term) Provide decision support systems able to "learn" from
        previous planning/decisions, as well as important lessons learned .

3. CONNECTIVITY	Quartile	CTI
a. Control and manage communication resources to achieve robust, efficient transfer of information.	I	4-A
		4-B
(1) Spectrum Management: Use the electromagnetic spectrum efficiently over all military bands.		4-C
		4-G
(2) Bandwidth management: Provide dynamically assigned bandwidth in accordance with user requirements.		
(3) Traffic control: Ensure dynamic routing and prioritization.		
(4) Power management: Dynamically control radiated power to maximize network capacity and minimize interference.		
(5) Access: Provide access to communication services to all users.		
(6) Information Management: reliably transfer information using the minimum communication resources.		
b. Extend full range of communications services to all users.	I	4-A
(1) Data-transfer: Provide high data-transfer rate to mobile users to support timely retargeting (air tasking order (ATO) and Tomahawk mission data update (MDU)), imagery, video teleconferencing, etc.		4-B
		4-C
		4-D
(2) Mobility: Provide full communications capability to mobile users.		4-E
(3) Platform integration: Ensure ability of all platforms to fully participate in communications services.		4-G
(4) Exploitation of commercial services: Integrate commercial communications services into military networks.		
(5) Shared-aperture antennas: Reduce the number of antennas aboard ships through development of multi-band, multi-functional antenna.		
(6) Universal radio: Reduce the number of radio types used in the three services through development of a multi-band, multifunctional, programmable radio.		
(7) OTH: Provide point-to-point communications without satellite over a 200-mile range.		
(8) Multimedia communications services: Provide seamless transfer of information in any format (voice, data, imagery, video).		
(9)..Tactical data link interoperability: Ensure seamless transfer of data among joint service tactical data links.		
(10) Geographic coverage: Provide communications to users anywhere.		
c. Provide appropriate quality and type of service to all users.	I	4-B
(1) Reliability/availability: Provide assured communications at any time.		4-C
(2) Timeliness: Ensure sufficiently low latency to support all users.		4-D
(3) Stealth management: Manage transmission power, beam shape, beam direction, wave forms, routing, and routing info to minimize detection.		4-E

d. **Ensure communications in the military environment with the**   I   4-C
    following system attributes: 4-E
    (1) Protected: Ensure resistance to communications countermeasures   4-G
          (Anti-jam, anti-spoof, etc.).
    (2) Reconstitutable: Ensure recovery of communications capabilities
          following damage of loss (intended or otherwise).
    (3) Seamless: Make communications process transparent to the user.
    (4) Interoperable: Enable comms with other services and allied forces.
    (5) Mission Reconfigurable: Provide capability to tailor system
          characteristics (e.g., wave form) for specific missions.
    (6) Open: Base system architectures on evolving commercial standards
          that allow affordable system growth in an open environment.
    (7) Secure: Provide multilevel information security over all networks.
    (8) Universal: Develop communication protocols to allow access to
          services by special users and other users under special circumstances.
    (9) Survivable: Make resistant to shock, water, etc.

4. COUNTER C^2 / C^2 PROTECTION	Quartile	CTI
a. Develop wide-area anti-sensor weapons for deception, disruption, denial and destruction.	I	
b. Develop wide-area anti-communications weapons for deception, disruption, denial and destruction.	I	
(1) Above ground.		
(2) Below ground.		
c. Develop anti-processor weapons.	I	
(1) Chip.		
(2) Software.		
d. Develop anti-infrastructure weapons.	I	
(1) Economic.		
(2) Political.		
(3) Transportation.		
(4) Energy.		
(5) Mass media.		
e. Improve ASW/MIW/AAW to provide impenetrable shield for critical C^2W nodes in the carrier battle force.	I	4-D
f. Preserve existing/planned C^2W weapons (jammers / SOF / HARM / precision guided munitions / bunker busters, etc.).	I	

g. Improve use of Red teams to assess C^2W vulnerability.   II

h. Improve own-force spectrum management.   III   4-C
     4-E
     4-G

5. C^2W PLANNING AND ANALYSIS	Quartile	CTI
a. Develop C^2W measures of effectiveness.	II	
b. Develop do-all joint C^2W command support system.	II	
c. Develop battle damage assessment for C^2W deception, disruption, denial and destruction.	II	
d. Develop integrated intelligence data base (standard formats/protocols).	III	4-A 4-B
e. Improve acquisition system effectiveness and responsiveness.	III	
f. Increase utilization of national sensors by tactical forces.	III	4-A
g. Increase utilization of intelligence data bases.	III	4-A
h. Improve visualization of C^2W effects.	IV	4-F
i. Find an alternative for relying on intell for mapping C^2 networks and decision making.	IV	

6. ENABLERS	Quartile	CTI
a. (Prototyping) Guarantee highly effective fielded C^4I systems through analytical tools.	III	4-F

     (1) Develop accurate simulation and modeling technologies including improved meteorological and oceanographic nowcasting and forecasting which will have a high degree of prediction capability.

     (2) Carry out a coherent process of realistic live and constructive exercises, including simulations, at various levels of resolution, which will include evaluations of new technology initiatives.

     (3) Develop decision aids that support analyses of tactical options for on-scene commanders.

     (4) Implement a development process that will guarantee ultimate delivery of operationally survivable C^4I systems.

b. (Interoperability) Provide the capability to carry out C^{4}I processes   **IV**   **4-A**
without regard to details of platform, mode, service, or nationality.   **4-B**
    (1) Fully implement open system standards based on minimal sets of   **4-C**
          supporting joint and international standards.
    (2) Develop and implement military standards which reflect commercial
          standards, processes and procedures to the greatest extent practicable.
    (3) Develop an integrated family of C^{4}I systems capable of meeting a full
          range of operational requirements, from crisis to combat.

c. (Logistics/Sustainability) Integrate all support functions (including   **IV**
logistics, training, medical and personnel) within the C^{4}I architecture.
    (1) Ensure that continua for individual and team C^{4}I training are seamless
          (fully embedded and pipelined) and that elements of the continua are
          available to intended users whenever desired.
    (2) Ensure that C^{4}I systems training reflects realistic operational
          environments. This should include the full range of subject matter,
          from operational availability through tactical interactions.
    (3) Ensure development/availability of means and measures for evaluating
          effectiveness of the C^{4}I training system so operational commanders
          can at any time assess their forces' C^{4}I readiness.
    (4) Implement system development cycles short enough that products are
          synchronized with technological innovations and meet emerging
          needs.
    (5) Provide warning to prevent personnel, ship, aircraft and facility
          damage from weather and ocean conditions, in port or underway.

Chapter 5

Strategic Deterrence

Strategic vision: Achieve deterrence by causing an adversary or potential adversary to decide against taking specific actions contrary to U.S. vital interests. Deterrence is a state of mind created by a credible threat of unacceptable action or counteraction, the perception that the cost of the unacceptable behavior will exceed any possible gain, or the perception that the action would not succeed.

Definition and Scope

As defined for the Joint Mission Area / Support Area assessment, strategic deterrence is the use of political, economic and military capabilities to create a credible threat of unacceptable counteraction that causes an adversary to decide against specific actions. It creates a perception that cost exceeds gain and that actions hostile to U.S. interests would fail. Strategic deterrence considers all platforms and systems that contribute to deterrence using nuclear, conventional, and unconventional weapons and technologies.

Functional Description

The objective of this technology area is to build systems that make a potential enemy's attack so costly that it will deter even consideration of an attack. Principal components are as follows:

Information architecture and management technological improvement seeks to maximize control of friendly forces by creating a tactical and a logistical environment that allows collaborative planning and information sharing. Tactically, these technological trends suggest the creation and use of information paths that allow friendly forces to recognize and react quickly to indication and warning (I&W). Logistically, this element seeks to create an environment in which military hardware can be procured, deployed, and repaired quickly and easily.

SEW addresses DoN's ability to control and exploit the electro-magnetic spectrum. For friendly forces, this implies complete and facile use of the spectrum to control activities and then to assess the disruption of enemy C^4 in real time. It also means disrupting an enemy's ability to

coordinate and deploy forces. Technological challenges include creation of conformal antennae for all platforms and minimization of active emissions during communications to counter detection.

Survivable nuclear forces addresses the need to protect nuclear weapons and their command and control paths after a first strike. This suggests weapons hardening, weapons mobility, and portable command and control systems. It also requires techniques to counter recent gains in acoustic and non-acoustic anti-submarine warfare advances.

With fewer forces available, *defensive systems* assume greater importance for protection of battle groups, platforms, and personnel. Technology requirements include implementation of advanced Theater Ballistic Missile Defense (TBMD) systems as well as the protection of own forces from enemy passive sensors. One important component is an aggressive effort to build chemical/biological (CW/BW) defensive systems--systems that will detect the effluent as early as possible and then attack it as soon as possible. Finally, this area considers advanced techniques to improve personnel defense, with an emphasis on low-cost and comfortable body armor and CW/BW protection.

Technological improvement in *munitions* complements a smaller force structure. The challenge lies in developing munitions that destroy difficult targets such as defended bunkers and weapons that separate bunkers from command and control systems. This area also includes munitions that find and destroy fiber optic cables supporting wide-bandwidth communications.

The principal technological challenge to *joint/combined operating capabilities* is to remove doctrinal, language, and cultural barriers that limit the effectiveness of joint operations.

Strategic lift considers improvements to our ability to move personnel and material from ship to shore. It includes operations in much higher sea states than we currently undertake as well as an extension in the stand-off range.

Requirements

Examination of this technology area reveals some recurring themes:
- *Avoid predictable behavior.* Any system or technological change that keeps an enemy guessing makes it more difficult to rationalize an attack against friendly forces.
- *Communications and the maintenance of communications paths are vital.* Systems that maintain our communications paths and deny this ability to a foe merit investment.
- *Every service and several DoD technological areas have similar goals and similar programs.* We should investigate these program areas and combine when appropriate.

Underlying the vision for strategic deterrence are seven top-level warfighting functional requirements, prioritized as follows:

1. INFORMATION ARCHITECTURE AND MANAGEMENT.
2. SPACE AND ELECTRONIC WARFARE (SEW).

3. **SURVIVABLE NUCLEAR FORCES.**
4. **DEFENSIVE SYSTEMS.**
5. **MUNITIONS.**
6. **JOINT/COMBINED OPERATING CAPABILITIES.**
7. **STRATEGIC LIFT.**

Table 5 lists prioritized goals and objectives under each of the seven top-level warfighting functions. These goals and objectives represent S&T requirements for Strategic Deterrence. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Strategic Deterrence-related paragraphs in the CTIs, published verbatim in Appendix 5. For reference, Appendix 5 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 5. STRATEGIC DETERRENCE: PRIORITIZED S&T REQUIREMENTS

1. INFORMATION SYSTEM ARCHITECTURE AND MANAGEMENT	Quartile	CTI
a. Develop systematic means to coordinate intelligence and surveillance data against hostile nations	I	5-B
(1) Identify military, economic and political trends from psychological and cultural databases		
(2) Improve information sharing between civilian and military agencies.		
b. Develop interactive systems that forecast potential aggressive actions and recommend deployment of intelligence and surveillance actions.	I	
(1) Make effective use of future information highways.		
(2) Automate lower-level information processing.		
(3) Enhance ability to consider alternate forecasts.		

2. SPACE AND ELECTRONIC WARFARE (SEW)	Quartile	CTI
a. Improve C^4I and counter C^4I systems.	I	
(1) Develop portable and deployable systems that will deceive the enemy.		
(2) Maintain the ability to produce and deploy "trusted" software.		
(3) Support LPI communications.		
b. Improve ability to maintain assured communications connectivity.	I	
(1) Develop capability to retask blue assets.		
(2) Develop two-way submarine communications at depth and speed.		

c. Improve SEW C^{4}I planning.   **III**
    (1) Improve the ability to assess the success of current actions.
    (2) Develop an ability to anticipate enemy actions and counter-actions.

3. SURVIVABLE NUCLEAR FORCE	Quartile	CTI
a. Provide assured and survivable command and control.	I	

    (1) Build channels that transfer retargeting plans directly from planning authorities to onboard weapons systems.
    (2) Provide continuous, survivable and interoperable communications across the frequency spectra for delivery platforms.
    (3) Improve real-time transfer of new target packages to onboard weapons systems.

b. Improve platform survivability during communications   **I**
    (1) Develop techniques that allow comms receipt with conformal antennae.
    (2) Determine the terrain covertly in proximity of submarines.
    (3) Develop covert internal submarine navigational systems that provide continuous communications.
    (4) Minimize active emissions in submarine communications.
    (5) Develop means to counter enemy acoustic/nonacoustic ASW advances.

c. Improve force readiness through force sustainability modernization.   **II**
    (1) Employ technology advances to upgrade systems during normal maintenance or upgrade cycles.
    (2) Improve non-destructive tests of weapons system components to assess system operability.

4. DEFENSIVE SYSTEMS	Quartile	CTI
a. Increase combat countermeasures success against known threats to systems, platforms, and hardware.	I	5-A, 5-B

    (1) Reduce system and platform vulnerability to E/O sensors.
    (2) Reduce platform signatures with stealth; counter anti-stealth technology.
    (3) Develop multi-sensor/threat detection systems to perform automatic, real-time data fusion.
    (4) Develop and validate tactics to train operators and commanders with advanced modeling and simulation techniques.
    (5) Develop decisions aids and MOEs to help operators/commanders make better decisions.
    (6) Defeat/decoy/reduce force susceptibility to torpedoes.
    (7) Reduce non-acoustic surface/submarine signature.
    (8) Evaluate the susceptibility of submarines to commercial sensors.

b. Develop advanced active defensive systems.   I   5-A
  (1) Develop a TBMD capability that detects and attacks missiles in the boost phase and provides automated multi-sensor data fusion.
  (2) Provide capabilities to counter high altitude, long duration unmanned air vehicle (UAV).
  (3) Develop multi-sensors/satellite-linked/all-weather air dropped mines.
  (4) Develop systems to destroy weapons of mass destruction (WMD) vice just dispersing CW/BW agents.

c. Provide defensive systems against "dumb" weapons such as contact   I   5-A
  mines and straight running torpedoes.

d. Develop kinetic kill vehicles.   I   5-A

e Develop explosively driven, magnetohydrodynamics (MHD)   I
electromagnetic pulse generators.

f. Develop passive systems for personnel defense   II
  (1) Implement advanced respiratory protection and antibody development.
  (2) Develop agent-impermeable membranes.
  (3) Develop space-based techniques to detect/destroy CW/BW effluent.
  (4) Improve body armor.
  (5) Implement CW/BW countermeasures into ship and aircraft design.

5. MUNITIONS	**Quartile**	**CTI**
a. Develop munitions that detect, locate and destroy tunnels, bunkers, WMD storage sites, vent shafts, and sensors.	**II**	
b. Develop munitions that will attack deep, dispersed strategic C3, WMD, and leadership sites.	**II**	

  (1) Develop improved hard kill, penetrating weapons.
  (2) Develop soft kill systems against vent and power system.
  (3) Develop weapons to sever bunkers from C3 nodes, sensors & weapons.
  (4) Develop munitions that prevent weapons movement to firing positions.
  (5) Develop the capability to detect and destroy fiber-optic cables.

c. Improve the precision and accuracy of kinetic energy weapons.	**II**	**5-A**

6. JOINT/COMBINED OPERATING CAPABILITIES	**Quartile**	**CTI**

a. Allow deployed units to communicate with large, on-line joint databases.   II   5-B
  (1) Develop collaborative planning and virtual communications systems.
  (2) Develop a language/crypto independent virtual communications system.

b. Develop collaborative planning systems that allow joint/combined forces to operate as effectively as a single unit.   III   5-B
  (1) Develop system that simplify the replacement of a similar systems from other countries or services.
  (2) Development functional modeling techniques to support virtual reality and incorporate them into planning, training, and assessment processes.

c. Achieve functional standardization.   IV   5-B
  (1) Synchronize all joint/allied doctrine.
  (2) Develop smart verbal and written translators that simplify the exchange of ideas across cultures.

8. STRATEGIC LIFT (Air and Sea-Based)	Quartile	CTI
a. Improve near-term strategic lift.	IV	

  (1) Develop offshore basing technologies.
  (2) Allow operations in sea state 3 with an extension of standoff range.
  (3) Improve maintenance and repair, particularly salvage capabilities to exceed 500 tons.
  (4) Decrease susceptibility and vulnerability of lift platforms.
  (5) Expand underway replenishment capabilities.

b. Improve long-term strategic lift.   IV
  (1) Develop higher cargo transport rates.
  (2) Reduce the time and cost to load/offload lift platforms.
  (3) Allow operations in sea state 4 with an extension of standoff range.
  (4) Develop salvage capabilities in excess of 5000 tons.

Chapter 6

Maritime Support of Land Forces

Strategic vision: Achieve and maintain affordable strategic sealift and combat logistics capabilities to ensure the timely delivery of dry and liquid cargoes from ports of embarkation into littoral regions to sustain forces over the operational continuum.

Definition and Scope

As currently defined for the Joint Mission Area / Support Area assessment, maritime support of land forces includes surface-, undersea- and air-dominance functions that enable rapid deployment and sustainment of U.S. combat forces; functions, capabilities, platforms and systems necessary to establish and maintain superiority and to protect vital sea lines of communication; and the sealift capacity required to support deployment and to sustain operations.

When the FY 1995 S&T round tables took place, issues of battlespace dominance, superiority and protection were largely addressed in round tables other than maritime support for land forces. The Maritime Support round table covered the following areas (as does this chapter):
- Strategic sealift ships (organic/commercial); combat logistics force shuttle and station ships.
- Logistics over the shore (LOTS).
- Seabased maintenance.
- Salvage force ships.
- Protection, primarily in littoral environments.

Functional Description

Maritime support is key to wartime and peacetime deployment and sustainment of forces in forward areas. As the U.S. closes overseas bases, it becomes even more important for initial delivery and resupply of forces afloat and ashore.

Sealift, an integral part of maritime support, provides a maritime bridge to keep forces supplied with weapons, fuel, equipment, food, medical services and shelter. It is the most cost-effective method to transport large, heavy items such as tanks. (Airlift can move very high priority items

but is not cost effective for moving the bulk of resources.) Sealift moves supplies from CONUS to the theater of operation and offloads supplies at a safe port or seabase. The combat logistics force (CLF) then takes supplies to the combat area. Activities required for sealift and protection of sealift and sea lines of communication--and which are key to force sustainment for joint operations--include the following:

- Ensuring entry of equipment and resupply to maintain access to resources of national interest ashore.
- Responding on short notice to crises in areas where Naval Expeditionary Forces are forward deployed.
- Sustaining support for operations at sea or on land for an indefinite period.

Sealift and sealift protection have four stages:

- Peacetime sustainment: Maintenance of the necessary level of combat capability for peacetime forward presence in the absence of high-threat situations.
- Prepositioning: Movement of combat equipment and supplies to forward afloat positions to provide rapid response to hostilities.
- Surge: Rapid buildup of combat equipment and supplies from peacetime levels to warfighting levels. (Typically, surge flows from the U.S. as a follow-on to prepositioned cargo.)
- Wartime sustainment: Resupply of troops and equipment during a conflict over the long term to enable forces ashore to conduct operations.

Requirements

Underlying the strategic vision for strategic deterrence are six top-level warfighting functional requirements, prioritized as follows:

1. **JOINT LOGISTICS OVER THE SHORE (JLOTS) SYSTEM IMPROVEMENTS.**
2. **FUTURE SEALIFT CONCEPTS.**
3. **SUPPORT SYSTEMS.**
4. **COMBAT LOGISTICS FORCE.**
5. **OFFSHORE BASING.**
6. **SURVIVABILITY/PROTECTION (OPEN OCEAN AND LITTORAL).**

Table 6 lists prioritized goals and objectives under each of the six top-level warfighting functions. These goals and objectives represent S&T requirements for Maritime Support. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Maritime Support-related paragraphs in the CTIs, published verbatim in Appendix 6. For reference, Appendix 6 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 6. MARITIME SUPPORT FOR LAND FORCES: PRIORITIZED S&T REQUIREMENTS

1. JLOTS SYSTEM IMPROVEMENTS	Quartile	CTI
a. (Mid-term) Develop JLOTS deployment and retrieval technology to:	I	
(1) Reduce installation and retrieval times of JLOTS subsystems by 25% of established doctrine (e.g., elevated causeway).		
(2) Increase ability to operate through sea state 3.		
b. (Mid-term) Develop throughput technology to:	I	
(1) Increase ability to operate through sea state 3 in all phases of ship to shore cargo movement.		
(2) Provide a rapidly deployable bulk fuel delivery system to support the assault echelon and JLOTS that is capable of being installed within one day in sea state 3 and that can provide up to 1.2M gallons per day (gpd).		
(3) Extend standoff distances from the shore that support Operational Maneuver from the Sea (OMFTS).		
(4) Integrate LOTS capability with offshore basing and portable ports.		
c. (Mid-term) Improve/develop advanced modeling/simulation.	I	
(1) Develop operations analysis techniques to maximize effective use of JLOTS assets.		
(2) Develop synthesis models to support design, assessment and acquisition of future JLOTS systems.		
d. (Far-term) Develop JLOTS deployment and retrieval technology to:	I	
(1) Reduce installation and retrieval times of JLOTS subsystems by 50% of established doctrine (e.g., elevated causeway).		
(2) Increase ability to operate through sea state 4.		
e. (Far-term) Develop throughput technology to:	I	
(1) Increase ability to operate through sea state 4 in all phases of ship to shore cargo movement.		
(2) Provide rapidly deployable bulk fuel delivery system to support assault echelon and JLOTS that can be installed within 12 hours in sea state 4.		
f. (Far-term) Explore technology to reduce sea states > 5 to < 3.	I	
g. (Mid-term) Enhance Navy LOTS system interoperability with:	II	6-A
(1) Other services to standardize equipment, training, C^4I and doctrine.		
(2) Commercial maritime industry.		

2. FUTURE SEALIFT CONCEPTS	Quartile	CTI
a. Improve sealift platform concepts, design and equipment technology to yield significantly higher cargo transport rates.	I	6-A

(1): Evaluate Von Karman-Gabrielli Spectrum (generic lift/drag) for concepts with cost-effective vehicles for sealift in three speed ranges: 20-40 knots (midterm), 60-80 knots (far term),and 250+ knots (far term). High-value, time-critical goods require timely delivery.

(2) Explore technology to reduce life-cycle costs of sealift platforms.

(3) Provide improved air or surface craft for strategic lift and surge sealift.

b. Improve cargo-handling capability to reduce time and cost to load/offload sealift platforms (including offload capabilities at piers or via JLOTS in sea state 3+).	I	6-A 6-B

(1) Improve cargo delivery-rate technology with cargo-handling improvements which will lead to increased cargo density and reduced loading/unloading times.

(2) Integrate in transit visibility (ITV) technology and automated cargo-handling systems into sealift platform concepts.

(3) Identify alternative self-sustaining sealift platform concepts.

(4) Integrate sealift platform concepts with JLOTS requirements.

(5) Optimize cargo movement within sealift platform to minimize offload times and provide selective offload capabilities.

(6) Improve mooring and anchoring system of ship-to-pontoon, enabling cargo transfer in higher sea states.

(7) Explore technologies to improve Offshore Petroleum Discharge System (OPDS) capability.

(8) Ability to handle containerized ammunition.

c. Improve sealift platform regeneration capability.	I	

d. Improve sealift platform storage capability, inventory management and environmental control, and reduce maintenance of systems and stowage in long-term lay-up	I	6-A

e. Improve/develop advanced modeling/simulation.	I	6-A

(1) Develop operations analysis techniques to maximize effective utilization of sealift assets.

(2) Develop synthesis models to support design, assessment and acquisition of future sealift platforms and cargo throughput systems.

(3) Integrate ship design with ship production process.

f. Maximize merchant ship utilization: Identify dual-use technologies   **II**   **6-A**
    and platform concepts that improve commercial viability of militarily
    useful platforms and military effectiveness of commercial vessels.
    (1) Develop augmentation systems which provide enhanced cargo
        handling capabilities on existing and future merchant ships.
    (2) Develop augmentation systems which provide enhanced fuel produce
        transport and handling on existing and future merchant ships.
    (3) Develop and demonstrate cargo and terminal control systems for use
        in conjunction with augmented sealift support platforms.

g. Improve sealift platform deactivation and lay-up methods to preserve   **IV**   **6-A**
    and store platform/equipment to maintain its ability for rapid recall.

3. SUPPORT SYSTEMS	**Quartile**	**CTI**
a. (Mid-term) Explore technologies to provide improvements to the following salvage capabilities:	I	

    (1) Lightweight beach gear.
    (2) Rapidly deployable, easily relocatable, salvage lift (>500 tons).
    (3) Environmentally safe flotation foam for use in salvage operations.
    (4) Rapid emergency towing system.
    (5) Methods to identify, track and retrieve equipment, materials and
        supplies brought to an amphibious objective area from many sources.
    (6) Lightweight, low-maintenance towing hawser.
    (7) Improved, environmentally sound offship fire-fighting capability.
    (8) Autonomous underwater search system.
    (9) Fly-away, deep-ocean salvage system capability of 15 tons.
    (10) Remotely operated vehicle cable-splicing capability.
    (11) High-rate, oil-pollution containment and abatement system for
         operating up through sea state 2.

b. (Far-term) Develop technologies for rapidly deployable, easily   **I**
    relocatable salvage lift capability (> 5000 tons).

c (Far-term) Develop technologies for a rapidly deployable, chokepoint   **I**
    salvage clearance system.

d. (Mid-term) Explore technologies to improve the following   **II**
    maintenance and repair capabilities.
    (1) Open-ocean underwater BDA capability in sea state 3.
    (2) Underwater joining and cutting techniques for patching battle damage.
    (3) Low-maintenance material for JLOTS operation.
    (4) Portable, deck-mounted handling system for underwater husbandry
        and repair tasks.

4. COMBAT LOGISTICS FORCE (CLF)	Quartile	CTI
a. (Mid-term) Explore technologies to expand underway replenishment (UNREP) capability (station and shuttle ships).	I	6-B

    (1) Increase cargo throughput delivery capability by 25 percent.

    (2) Increase solid cargo transfer to 12K lbs. capacity.

    (3) Increase ship separation 250-350 feet.

    (4) Provide stowage, strike up/down, deck handling and transfer capability during sea state 5 and icing conditions.

    (5) Reduce manning and maintenance by 25 percent.

    (6) Improve receipt/strikedown rates to match CLF ship delivery rate.

    (7) Integrate ITV technology and automated cargo-handling systems into CLF platform concepts.

    (8) Optimize cargo movement within CLF platform to minimize offload times and provide selective offload capabilities

	Quartile	CTI
b. (Far-term) Develop UNREP capability for sending CLF and receiving surface ships to achieve the following objectives during deployment:	I	6-A

    (1) Reduce by 50 percent the number of UNREPs required per ship.

    (2) Reduce by 50 percent the UNREP time per ship.

    (3) Increase UNREP capability to sea state 7.

	Quartile	CTI
c. (Mid-term) Develop capability for merchant-ship use in CLF shuttle ship role.	III	

	Quartile	CTI
d. (Mid-term) Improve/develop advanced modeling/simulation.	III	6-A

    (1) Develop analysis techniques to maximize effective use of CLF assets.

    (2) Develop synthesis models to support design, assessment and acquisition of CLF platform designs and cargo throughput systems.

    (3) Integrate ship design with ship production process.

	Quartile	CTI
e. (Mid-term) Improve interoperability (incl. C^{4}I) of CLF platforms in joint/combined operations.	IV	

5. OFFSHORE BASING	Quartile	CTI
a. (Mid-term) Develop and demonstrate critical offshore basing technologies, including prototype testing, in the following areas:	II	6-B

    (1) Intermodule connector technology.

    (2) Sealift/CLF ship interface.

    (3) Cargo transfer, including automated cargo-handling systems.

    (4) Relocation and station-keeping capabilities.

    (5) Mooring capabilities in deep water (>10,000 ft.).

    (6) Advanced materials and manufacturing capabilities.

    (7) Fixed-wing flight operations.

b. (Mid-term) Ensure interoperability (incl. C⁴I) of offshore bases in joint/combined operations.   III

6. SURVIVABILITY/PROTECTION (OPEN OCEAN & LITTORAL)	Quartile	CTI
a. (Mid-term) Decrease vulnerability of sealift and CLF platforms.	III	6-A

   (1) Provide battle damage assessment and containment capability (incl. limiting loss of critical cargo and preventing sympathetic detonations).
   (2) Provide an automated, environmentally safe fire fighting system for sealift concept.
   (3) Provide damage-resistant, high-performance magazines/cargo holds.
   (4) Develop damage-tolerant designs.
   (5) Develop a real-time hull integrity monitoring system.

b. (Far-term) Explore technology for an advanced materiel transporter for independent operation at high speed (100+ knots), with no signature, impervious to attack, that can carry 10K tons and operate in a chemical/biological/radiation (CBR) environment.   III   6-A

c. (Mid-term) Decrease susceptibility of sealift and CLF platforms.   IV   6-A
   (1) Explore technologies to reduce signatures and provide effective countermeasures.
   (2) Provide more effective CBR detection and protection capability.
   (3) Explore affordable, modular alternatives to detect, identify and counter prevalent air, surface and subsurface threats.
   (4) Explore and develop a material transporter for Operational Maneuver from the Sea (OMFTS) with reduced signature and improved damage resistance.

Chapter 7

Forward Presence

Strategic vision: Forward naval forces (forward-deployed and -based) will protect and promote U.S. interests throughout the world, deter aggression, enhance regional stability, improve interoperability with allies, and provide timely initial crisis response.

Definition and Scope

Forward presence employs forward-based and forward-deployed naval forces to carry out a strategy of engagement around the world, prevention of crises and conflicts, and partnership with allies and friends. It considers the platforms and systems that allow us to wage war on enemy vice friendly terrain. Forward presence encompasses the following areas:

- Interoperability with other U.S. services forces and the military forces of friends and allies.
- Actions that enhance political stability and deter crises.
- Creation of a credible combat force for rapid crisis response.
- Dominance of the maritime battlespace, including littoral areas, to enable reinforcement from the sea.
- Cross-theater speed, mobility and applicability.

This mission area covers activities that range from the initial stages of a conflict to the delivery of forces that constitute a "shooting" war. Through successful integration of political and military intelligence, forward presence requires the quick deployment of forces that will deter an enemy from even attempting a hostile action. Through the creation of comprehensive defenses, it allows a Battle Group and friendly forces to enter highly defended areas with a high probability of success, further deterring an aggressor. Finally, it includes the delivery of weapons and troops on hostile beachheads in the ultimate extension of power. Success in this mission area protects and promotes US interests through the world, deters aggression, enhances regional stability, improves interoperability with allies, and provides timely initial crises response.

Functional Description

The principal dangers to be considered in shaping requirements for forward presence are threats to democracy and reform, proliferation of weapons of mass destruction, economic dangers and regional dangers. The method applied to generate requirements for forward presence is to translate strategic interests and regional political objective into military objectives and tasks with sufficient precision to allow the military to train, equip and organize forces for deployment.

The technology objectives for this area are to optimize performance and minimize costs of military personnel and systems engaged in this mission. Forward presence consists of eight thrusts:

Capability to project addresses Navy's ability to provide forces commensurate with the mission. This element is a superset of .other areas because it includes force composition, platform design and armament, maintenance of a flexible and minimized logistical pipeline, and the integration of intelligence into operations. While this domain is traditional, its extent is not--it includes all actions from peacetime maritime interdiction through a hot war.

Capability to move considers the ability of US and friendly forces to move into and within the theater regardless of environment, conditions, and distances. It requires self-sufficient forces that can remain on-station for long periods. This requires either elimination of support infrastructure or placement of the support infrastructure within the Battle Group.

Battlespace dominance encompasses offensive and defensive weapons superiority in environments ranging from maritime interdiction through hot war. Forward presence requires battlespace dominance under arduous conditions.

Since forward presence places forces in harm's way, *enable force self defense* considers active and passive systems that protect ships, aircraft and personnel from concerted attack. While friendly forces may face First and Third World foes, the spread of technology ensures that all adversaries will use First World weapons. Consequently, this area requires the deployment of advanced systems such as theater ballistic missile defense and several layers of protection against chemical and biological weapons.

Maintain C^4I Support considers an advanced use of intelligence and communications equipment to identify and deter aggressors while they are still considering an attack. This requires deployment of intelligence analysis systems that recognize patterns from disparate stimuli and then provide clear recommendations or incites decisions. It also includes systems that provide common situational awareness in tactical action so individual units can deploy weapons coherently.

Optimized interoperability describes how U.S. forces meld with one another and with international forces. This area requires tools that assist the integration of other cultures and doctrine of different services into a common frame of reference. It requires the decision aids to make these elements of the force interchangeable. This area requires the development of real-time voice and written language translators that provide context-sensitive translation.

environmental requirements and actions that are necessary to ensure that the environment does not impede the Navy's warfighting ability. Most future actions will include environmental constraints, whether compliance with different national pollution abatement requirements or operations in difficult and deadly environment, such as the Kuwait oil well fires.

Requirements

Forward Presence is an aggregate of capabilities and technologies Its requirements span the JMA/SAs, so priority setting is a difficult task.

Requirements associated with this area have grown significantly in recent years as a result of real-world experience. Since the Iranian revolution in 1979, the Navy has performed a nearly-continuous forward-presence mission in the Persian Gulf and the Indian Ocean. These commitments have stretched our logistical tail and have highlighted potential weaknesses, which this chapter addresses as requirements.

Underlying the strategic vision for forward presence are eight top-level warfighting functional requirements, prioritized as follows:

1. **CAPABILITY TO PROJECT POWER BY PROVIDING THE PRESENCE OF A NAVAL FORCE SUITABLE TO THE MISSION.**
2. **CAPABILITY TO MOVE NAVAL FORCES ANYWHERE IN A TIMELY MANNER.**
3. **BATTLESPACE DOMINANCE (TRANSITIONAL).**
4. **CAPABILITY TO SUSTAIN NAVAL FORCES ANYWHERE IN A TIMELY MANNER.**
5. **ENABLE FORCE SELF DEFENSE.**
6. **MAINTAIN C^{4}I SUPPORT (ACROSS ALL OTHER GOALS).**
7. **OPTIMIZED JOINT AND COMBINED FORCE INTEROPERABILITY.**
8. **ENVIRONMENTAL STEWARDSHIP.**

The two highest priority warfighting functions require innovation. While Navy has demonstrated the capability to project power and to move, these abilities were developed in a more generous funding environment. They received logistics support that is not likely to be available in the near future. Minimization of logistical requirements is extremely important for the accomplishment of this mission area.

Table 7 lists prioritized goals and objectives under each of the eight top-level warfighting functions. These goals and objectives represent S&T requirements for Forward Presence. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Forward Presence-related paragraphs in the CTIs, published verbatim in Appendix 7. For reference, Appendix 7 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 7. FORWARD PRESENCE: PRIORITIZED S&T REQUIREMENTS		

1. CAPABILITY TO PROJECT POWER BY PROVIDING THE PRESENCE OF A NAVAL FORCE SUITABLE TO THE MISSION	Quartile	CTI
a. **Provide capability to engage all air, surface and subsurface targets:**	I	7-D

a. **Provide capability to engage all air, surface and subsurface targets:**
   (1) Respond in the appropriate, critical time frame.
   (2) Provide sustainable fire power.
   (3) Have the capability to execute deep strike missions.
   (4) Minimize damage to nonmilitary equipment, civilians and third parties.
   (5) Have on hand the munitions mix appropriate to the mission.
   (6) Offensive actions should be measured and appropriate to the situation.
   (7) When possible, use nonlethal weapons to accomplish the mission.
   (8) Use munitions that cannot be traced back to the user.

b. **Provide the capability to control key terrain.**   I
   (1) Ensure that all forces are self-sufficient.
   (2) Ensure that all forces are survivable.
   (3) Provide enhanced mobility for all forces, and be able to counter the movement of (potential) enemy forces.
   (4) Provide capability (e.g., on peacekeeping missions) to interface with local infrastructure.
   (5) Ensure that appropriate naval personnel have knowledge of the local political and social structure.

c. **For missions such as blockades, embargoes or quarantines, provide the capability to conduct maritime intercept operations.**   I
   (1) Provide capability to tag and track all shipping--neutral, friend, foe.
   (2) Provide capability to inspect shipping by noninvasive methods.
   (3) Control movement/intent of shipping by nonlethal methods.

d. **Provide the capability to conduct naval operations other than war.**   I
   (1) Provide forward presence naval forces with capabilities necessary to conduct operations such as peace making, peace keeping / enforcement, disaster relief and humanitarian assistance.
   (2) Provide sea-based forward presence forces with capability to support all operations ashore.

e. **To maintain proficiency, to prepare for possible war, or to deter war, forward presence forces must have the capability to conduct all appropriate naval exercises.**   II

2. CAPABILITY TO MOVE NAVAL FORCES ANYWHERE IN A TIMELY MANNER.	Quartile	CTI
a. Ensure the availability of appropriate platforms.	I	7-B
(1) Provide platforms that are functionally suitable, flexible and responsive to forward presence missions.		
(2) Provide a force whose size and capacity are appropriate to the mission.		
b. Provide platforms with the capability to operate in all possible / expected sea states and weather conditions.	I	7-B
(1) Provide platforms that can transit unimpeded by weather or sea state.		
(2) Enable forces to exploit all available meteorological and oceanographic data to transit and operate in all weather and sea-state conditions.		
c. Enable forces to transit clandestinely.	II	7-B
(1) Provide platforms with dynamic signature control.		
(2) Make use of deception and operational security methods.		
d. Enable platforms to transit unconstrained by logistics considerations.	II	7-B
e. Ensure availability of infrastructure needed to accomplish the mission.	III	7-B
(1) Ensure overseas support from friends/neutrals, especially regional.		
(2) Ensure domestic support.		
f. Ensure multi-source political support for forward presence operations.	III	
(1) Domestic or home-front political support is required.		
(2) Political support from regional and/or host countries is needed.		
(3) Global or international political support is required.		
g. Provide capability for transit planning.	IV	7-B
(1) All requirements to support the transit must be met.		
(2) Update, populate, maintain applicable databases (e.g., METOC).		
(3) Appropriate resources (e.g., platforms) must be selected and allocated.		
(4) The appropriate route must be selected based on requirements (e.g., quickest, most deceptive or most visible route).		

3. BATTLESPACE DOMINANCE (TRANSITIONAL).	Quartile	CTI
a. Within regional area of interest, achieve and maintain air superiority.	I	7-D
b. Achieve and maintain surface superiority at sea or on land.	II	7-D
c. Achieve and maintain space and electronic warfare superiority.	II	7-C, 7-D

5. ENABLE FORCE SELF-DEFENSE.	Quartile	CTI
a. Provide capability to defend against a variety of air threats.	I	7-D

   (1) Develop capability to defeat wide variety of launched threat munitions:

      (a) Cruise missiles (antiship and coastal).

      (b) Air-to-air weapons (e.g., missiles).

      (c) Theater ballistic missiles.

      (d) Directed-energy weapons (lasers, high-power microwave).

      (e) Rockets of all types, including those with chem/bio warheads.

      (f) Gun fire.

      (g) Aircraft-launched bombs (dumb and smart).

      (h) Aerosol weapons.

   (2) Provide capability to defeat shooter, launcher or site:

      (a) Aircraft.

      (b) Transporter erector launchers (mobile sites).

      (c) Subsurface craft.

      (d) Surface craft.

      (e) Land-based, fixed sites.

      (f) Multiple-warhead TBMs.

      (g) TBM sites/launchers

      (h) Artillery equipment and sites.

      (i) Man-portable launchers/sites.

      (j) Space-based launchers.

| **b. Provide capability to defend against a variety of surface-related threats.** | II | 7-D |

   (1) Develop capability to defeat various surface-launched threat munitions:

      (a) Cruise missiles (sea-skimming antiship and coastal).

      (b) Mines (at sea and on land).

      (c) Torpedoes.

      (d) Theater ballistic missiles.

      (e) Rockets of all types, including those with chem/bio warheads.

      (f) Aircraft-launched bombs (dumb and smart).

      (g) Directed-energy weapons (lasers, high-power microwave).

      (h) Gun fire.

      (i) Aerosol weapons.

      (j) Mammal-delivered munitions.

   (2) Provide capability to defeat shooter, launcher or site:

      (a) Aircraft.

      (b) Subsurface craft.

      (c) Surface craft.

      (d) Multiple-warhead theater ballistic missiles.

    (e) Land-based, fixed sites.
    (f) Transporter erector launchers.
    (g) Underwater fixed sites.
    (h) Artillery sites.
    (i) Tanks.
    (j) Space-based launchers.
    (k) Man-portable launchers/sites.
    (l) Mammals.

c. Provide forward presence platforms and systems with high degree of force survivability.　　II　　7-D
  (1) Reduce platform and system vulnerability by:
    (a) Providing designs that are inherently damage resistant.
    (b) Providing for effective damage control (e.g., firefighting).
  (2) Reduce platform and system susceptibility by:
    (a) Reducing platform and system signatures.
    (b) Developing methods to avoid the threat.
    (c) Providing agile or quick-maneuvering platforms.

d. Provide capability to defend against variety of subsurface threats.　　IV　　7-D
  (1) Develop capability to defeat variety of launched threat munitions:
    (a) Mines (at sea and on land).
    (b) Torpedoes.
    (c) Depth charges.
    (d) Directed-energy weapons.
    (e) Mammal-delivered munitions.
  (2) Provide capability to defeat shooter, launcher or site:
    (a) Subsurface craft.
    (b) Aircraft.
    (c) Surface craft.
    (d) Underwater fixed sites.
    (e) Land-based, fixed sites.
    (f) Mammals.

6. MAINTAIN C^{4}I SUPPORT (ACROSS ALL OTHER GOALS).	Quartile	CTI
a. Provide timely, tailored and common situational awareness.	II	7-C,
(1) Develop improved means for determining hostile intent.		7-D
(2) Develop improved means to provide forces with info requested.		
(3) Develop means to ensure perfect operator knowledge.		
(4) Develop clear and easily comprehended presentation methods.		
(5) Develop capability for system-based risk management.		
(6) Develop improved information processing methods.		
(7) Develop means to anticipate force information requirements.		

b. Assure connectivity of information flow among joint / combined forces. III 7-C, 7-D
   (1) Develop architectures that are adaptable to any situation.
   (2) Develop info-flow methods that circumvent language differences.
   (3) Develop info-flow techniques not exploitable by unauthorized users.

c. Provide all surveillance information appropriate to the mission. III 7-C, 7-D
   (1) Develop methods to integrate and fuse all data acquired.
   (2) Develop efficient means to transmit all acquired data and knowledge.

d. Provide for the timely receipt and dissemination of intelligence data acquired from all sources. III 7-C, 7-D

e. Provide for improved management of acquired information. IV 7-C, 7-D
(1) Develop improved methods to fuse, process, assess and disseminate data.
(2) Develop improved decision aids.
(3) Develop improved planning methods.
(4) Develop data-management methods not exploitable by unauthorized users.
(5) Develop means to maintain data bases.
(6) Develop methods to sanitize information automatically.

f. Conduct effective command and control warfare (C^2W). IV 7-C, 7-D
(1) Develop methods for improved protection of C^2 assets and techniques.
(2) Develop improved methods to counter enemy C^2 assets and methods.

7. OPTIMIZED JOINT AND COMBINED FORCE INTEROPERABILITY.	Quartile	CTI
a. Provide seamless command and control.	II	7-C
b. Improve coordination of joint/combined doctrine.	III	7-C
c. Improve proficiency in joint/combined operations and exercises.	III	7-C
d. Develop methods to improve control of joint/combined functions.	IV	7-C
e. Provide seamless logistics for joint/combined operations.	IV	7-C

8. ENVIRONMENTAL STEWARDSHIP.	Quartile	CTI
a. Develop capability to operate unimpeded by environmental issues.	IV	7-A
b. Develop improved methods to maintain the health of US forces.	IV	7-A
c. Improve waste management (e.g., reduce expendables).	IV	7-A

Chapter 8

Readiness

Strategic vision: Ensure that DoN maintains the ability of its forces, units, weapon systems and equipment to deliver outputs for which they are designed by accurately measuring present readiness, effectively forecasting future readiness and appropriately applying resources.

Definition and Scope

Readiness includes Navy and Marine Corps personnel, equipment, services and facilities that directly prepare and maintain operating forces. The FY 1995 Readiness S&T round table addressed the following areas, some of which are covered in greater detail in other chapters:
- Maintenance.
- Personnel.
- Safety.
- Training.
- Spares.
- Munitions.
- Logistics.
- operational tempo (OPTEMPO)/force structure balance.
- Steaming days, flight-hour program and ground operating consumables.
- Sustainability.

Functional Description

The overall objectives of this area are the creation and sustained support of combat forces that respond to command needs. Support takes many forms:

Material support includes commodities management (e.g., inventory, storage, rework, disposal, reutilization), war reserves and prepositioned material.

Transportation support includes battle-force shuttle-ship lift, Navy-unique sealift, transportation command (USTRANSCOM)-provided airlift, sealift and terminal support, Navy organic lift, the

ready reserve force, the Merships Naval Augmentation program, and material retrograde movement and cargo handling.

Terminal support and cargo handling includes logistics-over-the-shore (LOTS) and conducting operations without fixed port facilities.

Maintenance support includes direct fleet support, ship and aircraft depot-level maintenance, intermediate-level maintenance afloat and ashore, in-service engineering, ship and aircraft inactivation, and battle-damage repair.

Weapon-system support includes fleet modernization, integrated logistics support, configuration management, standardization, industrial base, manufacturing technology, technical support and in-service engineering.

Shore support includes shore base operations (e.g., physical security, waterfront and airfield operations, utilities, emergency services) and infrastructure (physical plant) construction.

Safety and environmental support includes industrial safety, environmental protection, occupational health, radiological control safety, and Nuclear Regulatory Commission compliance. Safety efforts include programs designed to prevent mishaps or to minimize injury to personnel and damage to equipment during non-combat operation of aircraft, boats, ships and submarines.

Requirements

Underlying the strategic vision for readiness are 13 top-level warfighting functional requirements, prioritized as follows:

1. **DEVELOP PROCESSES AND TECHNOLOGIES THAT INCREASE THE EFFICIENCY AND DECREASE THE COSTS OF PERFORMING MAINTENANCE.**
2. **DEVELOP AND IMPLEMENT A SEAMLESS, INTEROPERABLE LOGISTICS CAPABILITY.**
3. **DEVELOP FLEXIBLE, ACCURATE, MEANINGFUL MOEs FOR READINESS.**
4. **PREVENT ALL CLASS A AIRCRAFT MISHAPS.**
5. **TRAINING.**
6. **MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPS.**
7. **IMPROVE AT-SEA SUSTAINABILITY.**
8. **IMPROVE FORCES ASHORE SUSTAINABILITY.**
9. **IMPROVE STOWAGE ECONOMY, ACCESSIBILITY AND INVENTORY CONTROL.**
10. **IMPROVE SURVIVABILITY THROUGH DAMAGE CONTROL/PERSONNEL PROTECTION/FIRE FIGHTING.**
11. **PREVENT ALL AFLOAT CLASS A MISHAPS.**
12. **PREVENT ALL OTHER MISHAPS.**

13. PERSONNEL TEMPO (PERSTEMPO)/DEPLOYMENT TEMPO (DEPTEMPO)-- FORCE STRUCTURE BALANCE.

Table 8 lists prioritized goals and objectives under each of the 13 top-level warfighting functions. These goals and objectives represent S&T requirements for Readiness. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Readiness-related paragraphs in the CTIs, published verbatim in Appendix 8. For reference, Appendix 8 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 8. READINESS: PRIORITIZED S&T REQUIREMENTS		
1. DEVELOP PROCESSES AND TECHNOLOGIES THAT INCREASE EFFICIENCY AND DECREASE COSTS OF PERFORMING MAINTENANCE.	**Quartile**	**CTI**
a. Reduce inspection requirements and perform maintenance based on system condition; develop prognostic technologies and methodologies for predicting failures, including probable time to failure. (1) Automated nonintrusive diagnostics (remote, built-in). (2) Ad hoc data query / data sharing.	I	8-A
b. Design-in increased reliability, maintainability and availability; e.g.: (1) Interchangeable systems. (2) Modular systems. (3) Nonfluid power lubricating and cooling.	I	8-A
c. Improve methods to perform maintenance at most effective level.	I	8-A
d. Eliminate equipment-removal requirement for test and calibration: (1) Miniature calibration and test equipment. (2) Interactive interfaces between multiple pieces of equipment. (3) Remote automated test and calibration. (4) Self-calibration and test.	II	8-A
e. Develop new techniques/materials to eliminate corrosion/fouling: (1) Materials and coatings engineered for the life of the system (2) Low-cost/low-manpower surface preparation (3) Alternative concepts for corrosion protection (4) Environmentally benign internal/external anti-fouling (5) Non-surface preparation (6) Non-intrusive detection	II	8-A

f. Develop processes and technologies that support joint and coalition **II**
   interoperability.

g. Design for improved technology insertion and product improvement. **II**
   (1) Flexible design interfaces (online insertion of new systems)
   (2) Total life-cycle cost analysis tools

2. DEVELOP AND IMPLEMENT A SEAMLESS, INTEROPERABLE LOGISTICS CAPABILITY.	Quartile	CTI
a. Provide a standardized, adaptable, integrated logistics support system.	I	

   (1) Decision analysis support system (integrated maintenance, supply,
       configuration and data).
   (2) Single, simplified, standardized accounting (property & financial)
       system for ashore/afloat assets.
   (3) Total asset visibility and accessibility from manufacturer to end user.
   (4) Real-time interface with transportation system.

b. Develop realtime design/logistics interface that ensure that products **III**
   reflect actual system configuration.
   (1) 100% accuracy of product, technical and training manuals,
       maintenance capability, piece part.
   (2) In-situ validation.
   (3) Automated, simultaneous, low-cost, rapid, concurrent update.

3. DEVELOP FLEXIBLE, ACCURATE, MEANINGFUL MEASURES OF EFFECTIVENESS FOR READINESS.	Quartile	CTI
a. Develop MOEs for training.	I	
b. Establish mission/readiness relationships	I	
c. Develop capability to assess readiness impact of deviation from plan.	I	
d. Develop quantitative mission and performance criteria.	IV	
e. Develop performance-measure information infrastructure.	IV	

4. PREVENT ALL CLASS A AIRCRAFT MISHAPS.	Quartile	CTI

a. Eliminate human-cause factors.   I
   (1) Provide a manageable cockpit workload for all scenarios through:
      (a) Full-time tactically integrated ground collision avoidance system.
      (b) Information assimilation and integrated workload planning.
      (c) Adequate simulators/training devices (e.g., night vision goggles (NVGs))
      (d) Mid-air collision avoidance system.
      (e) Adequate aircrew displays.
      (f) Improved software safety analysis tools.
   (2) Provide training in:
      (a) Aircrew coordination.
      (b) Human factors.
      (c) Mid-air collision avoidance.
      (d) G-LOC (loss of consciousness (prevention.
   (3) Provide risk-assessment/risk-management tools for aviation evolutions.
   (4) Develop ergonomic designs providing:
      (a) Night vision device integration.
      (b) Ease of use.
      (c) Design escape system for physically smaller population.

b. Maximize survivability/minimize damage.   I
   (1) Improve crash survivability for helicopters and vertical take off and landing (VTOL).
   (2) Provide expanded emergency escape envelope.
   (3) Provide de-lethalized cockpit and crew stations.
   (4) Provide stable helicopter buoyancy system.
   (5) Predictive causative factor correlation for determining potential safety hazards.
   (6) Provide low-combustibility fuels and fuel systems.
   (7) Provide adequate fire-suppression and reflash systems.
   (8) Provide nonflammable/nontoxic hydraulic fluid compatible with current systems.
   (9) Provide improved fuel containment.
   (10) Provide remote siting capability for gearbox oil level.
   (11) Meet requirements for onboard oxygen generating system (OBOGS) operations in a CBR environment.

c. Eliminate material-cause factors.   II
   (1) Provide improved engine-failure prediction.
   (2) Provide improved failure prediction.
   (3) Provide safer catapult-gear energy delivery and control.

5. TRAINING.	**Quartile**	**CTI**

a. Ensure live-fire training capability.	**II**
b. Develop alternatives to live-fire training	**III**
c. In situ training (reduced training time away from unit).	**III**
d. Common architectures for training systems.	**IV**
e. Develop integrated risk assessment/risk management tools for all training evolutions.	**IV**

6. MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPERATIONS	Quartile	CTI
a. Ensure fuel availability and quality (without increasing cost) while increasing performance, safety and reliability (1) Affordable, universal fuel. (2) Develop alternative fuels (e.g., nonperishable). (3) In-line purification. (4) Portable, miniaturized fuel quality analyzer.	I	
b. Increase energy efficiency of naval systems and equipment. (1) Improve fuel economy. (2) Real-time efficiency measurement. (3) Effective bio-fouling control to increase hull efficiency.	I	

7. IMPROVE AT-SEA SUSTAINABILITY.	Quartile	CTI
a. Decrease cycle time for resupply. (1) Decrease turnaround time for resupply ships (e.g., automated handling / management, ship design). (2) Decrease frequency.	II	
b. Develop alternative methods to replenish all ships and boats (e.g., refueling ships from submerged oilers, material compression / expansion, logistics aircraft).	II	
c. Develop multipurpose logistics ships. (1) Interchangeable storage and weapons spaces.	III	
d. Develop at-sea re-arm capabilities.	III	
e. Improve cargo/weapons handling from hold to weather deck. (1) Mechanized capability (e.g., exoskeleton).	IV	

8. IMPROVE FORCES ASHORE SUSTAINABILITY.	Quartile	CTI
a. Develop alternative methods to resupply forces ashore (e.g., expeditionary airfields, forward logistics support sites).	III	
b. Decrease cycle time for resupply.	III	
(1) Decrease turnaround time for resupply (incl. automated handling / management, platform design).		
(2) Decrease frequency (incl. weapons design).		
c. Improve cargo/weapons handling from sea to shore.	III	
(1) Provide mechanized capability.		
d. Develop multipurpose logistics ships.	III	
(1) Interchangeable storage and weapons spaces.		

9. IMPROVE STOWAGE ECONOMY, ACCESSIBILITY AND INVENTORY CONTROL.	Quartile	CTI
a. Minimize stowage and handling demands.	II	
b. Develop improved shipping containers/systems that are lightweight, high-strength, low-volume, shock-absorbent and nontoxic.	II	
c. Maximize stowage and handling capability.	III	
(1) Cargo handling deck.		
(2) Flexible storage.		
(3) Reduced explosive arc.		

10. IMPROVE SURVIVABILITY THROUGH DAMAGE CONTROL/PERSONNEL PROTECTION/FIRE FIGHTING.	Quartile	CTI
a. Maximize damage control/personnel protection capability.	II	
(1) Provide alternative breathing sources.		
(2) Provide expanded emergency escape capability.		
(3) Determine personal protective equipment requirements for protection from chemical, biological and radiological attack.		
(4) Predictive/causative factor correlation for determination of potential safety hazards.		
(5) Provide risk-assessment/risk-management tools for fire fighting and damage control evolutions (incl. operations in CBR environment).		
(6) Determine requirements for fire fighting / damage control in a CBR environment.		
(7) Meet requirements for operations in CBR environment.		

b. Maximize fire-fighting capability.   **IV**
   (1) Provide low-combustibility fuels and fuel systems.
   (2) Provide adequate fire suppression and reflash systems.
   (3) Provide improved fuel containment.
   (4) Provide effective, safe and environmentally sound HALON and AFFF replacement.
   (5) Provide fire source diagnostic systems (rapid smoke suppression / elimination).
   (6) Provide nonflammable, nontoxic hydraulic fluid that is compatible with existing systems.
   (7) Reduce weight of fire fighting ensemble.
   (8) Provide heat-reactive bulkheads.
   (9) Provide full fire-fighting potential of fog stream application.

11. PREVENT ALL AFLOAT CLASS A MISHAPS.	Quartile	CTI

a. Eliminate human-cause factors.   **II**
   (1) Provide manageable bridge team workload:
       (a) Full-time and tactically integrated collision and grounding avoidance system.
       (b) Information assimilation.
       (c) Adequate simulators/training devices.
       (d) Crew coordination.
       (e) Automatic station keeping.
   (2) Training.
       (a) Provide bridge team coordination training.
       (b) Provide bridge team collision-avoidance training.
   (3) Ergonomic design.
       (a) Night-vision device integration.
       (b) Ease of use.
   (4) Risk-assessment/risk-management tools for shipboard evolutions.

b. Eliminate material cause factors.   **IV**
   (1) Provide failure prediction for arresting gear.
   (2) Provide improved open-ocean and land control of target drones.

12. PREVENT ALL OTHER MISHAPS.	Quartile	CTI

a. Eliminate human-cause factors.   **IV**
   (1) Reduce crew workload: adequate simulators / training devices (e.g., night vision goggles).

b. Maximize survivability / minimize damage.   **IV**

    (1) Provide predictive / causative factor correlation for determination of potential safety hazards.

    (2) Risk assessment algorithm for mission planning and execution.

    (3) Provide all-weather, emergency electrical power.

    (4) Provide safer scuttles and hatches.

    (5) Provide computer-based program for safety input to ship design.

    (6) Provide morphology-independent design.

    (7) Provide risk-assessment algorithm to assess explosive waivers.

    (8) Provide safety analysis of littoral warfare.

c. Eliminate material cause factors.   **IV**

    (1) Provide low-flammability fuels / reliable unmanned air vehicle (UAV) engines.

    (2) Provide "all-lighting-condition"-capable displays.

    (3) Provide joint/combined insensitive munitions.

    (4) Provide safer catapult gear energy delivery and control.

    (5) Provide triple-redundancy helo flight control systems.

    (6) Provide UAV flight controls and recovery systems.

    (7) Provide Recovery, Assistance, Securing, and Transversing (RAST) cable visibility.

    (8) Provide alternative cooling for avionics without impacting OBOGS breathing air and engine performance.

13. PERSTEMPO/DEPTEMPO--FORCE STRUCTURE BALANCE.	Quartile	CTI
a. Develop nonintrusive capability to track individual PERSTEMPO.	**IV**	

Chapter 9

Support and Infrastructure

Strategic vision: Determine the most cost-effective level of support and infrastructure to support peacetime readiness and wartime employment of the planned naval combat force structure.

Definition and Scope

Support and Infrastructure includes activities, programs and personnel in acquisition support, environmental support, information support, facilities and headquarters commands that furnish resources to or provide for naval operating forces. This area considers the most cost-effective approaches to managing DoN support functions and infrastructure. While it does not directly influence warfighting, it has significant indirect effects, such as (1) overhead costs of compliance with environmental regulations, (2) creation of information systems to improve information transfer between the Fleet and the shore establishment, to manage acquisition, and to reduce reliance on centralized databases, and (3) identification of novel test and evaluation procedures that do not cause environmental or noise pollution.

Technology in this area simplifies administrative and overhead processes, thus reducing their costs. These areas are important because the DoN's budget planning is a zero-sum game. A more efficient support and infrastructure process frees scarce funds for other warfighting missions and keeps our people and machines prepared for the next conflict. Due to the existence of similar issues in the private sector, this area has not seen major investments in S&T. As compliance costs rise and Navy-unique requirements grow, these areas become more important.

Functional Description

The objectives of this technology area are to optimize performance and minimize costs of DoN support and infrastructure systems. Efforts address 13 basic thrusts:

Systems, processes, and technologies that reduce manpower--Develops replacements for materials and compounds on ships and aircraft to reduce requirements for maintenance manpower.

Maximizing utility while reducing life-cycle cost of DoN infrastructure--Considers innovative ways to build and maintain the shore establishment in the face of austere funding. Includes relocatable facilities and virtual techniques to reduce brick-and-mortar costs.

Eliminating curtailment of military operations due to ship and A/C compliance requirements--Considers ship and aircraft modifications allowing operations in peacetime while complying with known environmental conditions. (Deals with platform and design issues vice administrative issues.)

Minimizing loss of budget due to cost of compliance--Seeks better, less expensive ways to comply with federal, state, and local regulations. Includes both administrative improvements (e.g., development of automated reporting techniques to meet compliance requirements) and technical considerations (e.g., techniques that solve engineering problems).

Minimizing the impact of energy cost and availability on naval operations--Considers measures that will enable Navy to operate with less energy and less cost. Includes alternate approaches to fuels management and alternate fuels, particularly for shore facilities.

Development of improved information support--Supports the creation of world-wide Corporate Information System that users can reach from anywhere in the world at any time.

Minimizing the effect of Halon-related loss of fire-fighting capability and explosion suppression--Supports development of a suitable substitute for Halon onboard ship.

Minimizing curtailment of military operations due to air pollution--Develops techniques that allow Navy to meet the most restrictive air pollution regulations. Includes long-range engine research to eliminate the problem.

Eliminating loss of test and evaluation (T&E) capability--Considers the effects of loss of range time and weapons-testing ability due to noise, air or other types of pollution. Includes alternate approaches to range management and testing requirements.

Minimizing loss of budget due to cost of restoration--Considers alternate approaches to clean-up management and any engineering or science necessary to meet these requirements. Includes administrative tools to simplify compliance.

Identification of techniques to rectify R-114-related loss of cooling in ships--Considers problems associated with identification and installation of alternate shipboard cooling media.

Minimizing curtailment of operations due to noise pollution--Considers operational application of noise-suppression technology as well as the effect of large, low-frequency acoustic sound transmitted in the water. Includes development of quieter aircraft engines.

Improvement of acquisition support--Supports integration of specific acquisition tools with the Corporate Information Management system. Includes novel approaches to model and simulation verification as well as techniques to minimize high cost system testing.

Headquarters and commands

Requirements

Underlying the strategic vision for support and infrastructure are 14 top-level warfighting functional requirements (prioritized):

1. **DEVELOP SYSTEMS, PROCESSES, AND TECHNOLOGIES THAT RESULT IN REDUCED MANPOWER.**
2. **MAXIMIZE UTILITY WHILE REDUCING LIFE-CYCLE COST OF DoN INFRASTRUCTURE.**
3. **CURTAILMENT OF MILITARY OPERATIONS DUE TO SHIP AND A/C COMPLIANCE REQUIREMENTS.**
4. **LOSS OF BUDGET DUE TO COST OF COMPLIANCE.**
5. **MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPERATIONS.**
6. **INFORMATION SUPPORT.**
7. **HALON-RELATED LOSS OF FIRE-FIGHTING CAPABILITY AND EXPLOSION SUPPRESSION.**
8. **CURTAILMENT OF MILITARY OPERATIONS DUE TO AIR POLLUTION.**
9. **LOSS OF T&E CAPABILITY.**
10. **LOSS OF BUDGET DUE TO COST OF RESTORATION.**
11. **R114-RELATED LOSS OF COOLING IN SHIPS.**
12. **CURTAILMENT OF OPERATIONS DUE TO NOISE POLLUTION.**
13. **ACQUISITION SUPPORT.**
14. **HEADQUARTERS AND COMMANDS.**

Table 9 lists prioritized goals and objectives under each of the 14 top-level warfighting functions. These goals and objectives represent S&T requirements for Support and Infrastructure. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Support and Infrastructure-related paragraphs in the CTIs, published verbatim in Appendix 9. For reference, Appendix 9 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 9. SUPPORT AND INFRASTRUCTURE: PRIORITIZED S&T REQUIREMENTS		

1. DEVELOP SYSTEMS, PROCESSES AND TECHNOLOGIES THAT RESULT IN REDUCED MANPOWER.	Quartile	CTI
a. Develop/identify more durable materials that require less maintenance	I	
b. Develop improved concepts and technologies (e.g., nonstandard supply process).	I	
c. Develop techniques to increase aircraft turnaround efficiency	I	
d. Develop techniques to reduce turnaround time (e.g., concurrent single-spot arming, refueling and inspection).	I	

2. MAXIMIZE UTILITY WHILE REDUCING LIFE-CYCLE COST OF DON INFRASTRUCTURE.	Quartile	CTI
a. Develop concepts, materials and techniques that permit reduced facilities investment. (1) Develop alternative construction materials and concepts. (2) Develop techniques that support condition-based maintenance. (3) Develop construction materials/techniques that allow one-time repair. (4) Develop techniques that support timely condition assessment. (5) Develop cost-effective concepts for multi-functional facilities. (6) Develop effective structural loading and response analysis models.	I	

3. CURTAILMENT OF MILITARY OPERATIONS DUE TO SHIP AND A/C COMPLIANCE REQUIREMENTS.	Quartile	CTI
a. Develop substitutes for hazardous materials and processes.	I	9-A
b. Develop processes for control and management of shipboard solid and plastic waste.	I	9-A
c. Develop processes for improved marine sediment/dredge spoil decontamination, remediation and reclamation.	I	9-A
d. Develop processes for control and management of shipboard non-oily liquid waste.	II	9-A
e. Develop processes for control and management of shipboard oily liquid waste.	IV	9-A

4. LOSS OF BUDGET DUE TO COST OF COMPLIANCE.	Quartile	CTI
a. Develop materials and processes for improved sensing/monitoring of contaminants in marine environments.	I	9-A
b. Develop methods for improved marine sediment/dredge spoil decontamination, remediation and reclamation.	II	9-A
c. Develop methods to control or reduce emissions from coatings, strippers and cleaners.	II	9-A
d. Develop standardized, regulator-approved methods and protocols for conducting environmental marine risk assessments.	II	
e. Develop improved methods for hazardous waste destruction ashore (e.g., lithium batteries).	II	
f. Provide improved field analytical sensors, methods and protocols to supplement traditional sampling and laboratory analyses.	II	
g. Develop improved processes for ordnance waste minimization and disposal (e.g., rocket-motor propellant removal and reclamation / destruction).	III	
h. Develop non-hazardous coatings, composites, processes and sealants.	III	9-A
i. Develop 3-D models of contaminant fate and effects in the marine environment.	IV	
j. Develop processes to control emissions from ordnance manufacturing and demilitarization.	IV	

5. MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPERATIONS.	Quartile	CTI
a. Increase DoN infrastructure energy efficiency.	I	
b. Increase naval facilities' energy independence.	I	

    (1) Provide active and passive, renewable, alternative energy sources.
    (2) Develop integrated thermal and electrical energy systems.
    (3) Provide multi-fuel-use engines.

6. INFORMATION SUPPORT.	Quartile	CTI
a. Provide improved, cost-effective data links between forward-deployed forces and the shore establishment.	I	
b. Provide improved user access to specific data.	II	
c. Provide improved information throughput in all environments.	II	
d. Provide multi-level security for naval information and communication systems.	II	
e. Provide person-to-person communications worldwide, anytime, anywhere.	II	
f. Reduce the need for nontactical, centralized information management commands.	IV	

7. HALON-RELATED LOSS OF FIREFIGHTING CAPABILITY AND EXPLOSION SUPPRESSION.	Quartile	CTI
a. Identify a Halon replacement for ships and vehicles.	II	9-A

8. CURTAILMENT OF MILITARY OPERATIONS DUE TO AIR POLLUTION.	Quartile	CTI
a. Develop effective power plants for ships that will comply with future emissions control standards.	I	
b. Develop methods to control emissions from all existing ship engines.	II	
c. Develop methods to control jet and rocket engine emissions.	III	
d. Improve the monitoring and sensing of toxic air emissions.	III	9-A

9. LOSS OF T&E CAPABILITY.	Quartile	CTI
a. Develop methods to reduce effects of beach and surf-zone T&E.	II	
b. Develop methods to reduce environmental effects of ship shock testing.	III	
c. Develop methods to reduce environmental effects of weapons testing.	III	

d. Provide improved techniques to assess and mitigate impact of specific   III
    operations on threatened and endangered species, marine mammals
    and habitats.

e. Determine effects of pollutants on threatened and endangered species   IV
    and marine mammals.

f. Develop improved procedures for blast-noise mitigation on test ranges.   IV

g. Develop techniques to reduce incidental intake of marine mammals   IV
    and threatened/endangered species.

10. LOSS OF BUDGET DUE TO RESTORATION.	Quartile	CTI
a. Develop improved methods for marine sediment/dredge spoil decontamination, remediation and reclamation.	II	
b. Develop materials and processes for improved sensing/monitoring of contaminants in marine environments.	III	
c. Provide improved field analytical sensors, methods and protocols to supplement traditional sampling and laboratory analyses.	III	
d. Develop standardized, regulator-approved methods and protocols for conducting environmental marine risk assessments.	III	
e. Develop 3-D models of contaminant fate and effects in the marine environment.	IV	
f. Develop real-time, in-situ sensor (incl. solvents, marine sediments, ordnance).	IV	
g. Develop atmospheric dispersion models.	IV	

11. R114-RELATED LOSS OF COOLING IN SHIPS.	Quartile	CTI
a. Provide capability for non-chlorofluorocarbons (non-CFC) vapor compression cooling.	IV	

12. CURTAILMENT OF OPERATIONS DUE TO NOISE POLLUTION.	Quartile	CTI
a. Determine the effects of acoustic emissions on marine mammals and threatened/endangered species.	IV	

13. ACQUISITION SUPPORT.	Quartile	CTI
a. Provide improved techniques for environmental impact assessment for new systems.	III	
b. Develop methods to integrate acquisition tools into the acquisition process.	IV	
c. Provide methods to improve modeling and simulation verification.	IV	
d. Develop techniques to reduce the utilization of T&E facilities	IV	

14. HEADQUARTERS AND COMMANDS.	Quartile	CTI

(No requirements identified for this function.)

Chapter 10

Manpower and Personnel

Strategic vision: Maintain and enhance warfighting and readiness by developing advanced technology to manage DoN's most important resource--the person--and to improve human-system performance.

Definition and Scope

As defined for the Joint Mission Area / Support Area assessment, manpower and personnel includes the billet structure, manning level and civilian/military mix of the shore and support establishment (including medical and reserve forces) necessary to provide essential support to active duty and combat forces. For the purpose of identifying S&T requirements through the round table process, the definition was broadened to encompass human-performance aspects of military systems, including human-system interfaces and human-performance measurement.

Technology in this area aids the forecasting of manpower requirements, placement of individuals in appropriate jobs, and improvement of the fit between humans and equipment. It includes tools for manpower planning; methods of personnel testing, selection, classification and utilization; methods of improving military performance and reducing the required numbers and skill levels of system operators and maintainers; and principles and techniques for the design, acquisition and use of military systems to provide an operating environment suited to human capabilities.

Functional Description

The objectives of this technology area are to optimize performance and minimize costs of military personnel and systems. Manpower and personnel issues belong to one of three basic thrusts:

Force management addresses DoN's ability to achieve the right shape, size and composition for maximum capability and flexibility. The right numbers of people with the right mix of skills will not fill billets by chance. Effective force management acquires capable people and assigns them to jobs for which they are qualified. DoN must anticipate manpower requirements, recruit individuals to fill those needs at the right time, match people to jobs, and manage careers to ensure retention of the top performers. Military force management also must reflect shifting resource constraints and major societal changes.

Performance enhancement addresses the ability of individuals, teams and units to conduct effective military operations under a variety of conditions. Human operators and maintainers are integral components of military systems so their performance must be factored into any meaningful test of overall system effectiveness. Moreover, just as we develop system improvements to correct shortfalls in hardware performance, we can develop performance aids, decision aids or other methods to improve the functioning of the human subsystem. Unfortunately, the difficulty of simulating battlefield conditions to test hardware performance also applies to testing human performance. DoN requires the ability to assess and predict military job performance and to diagnose, remedy or prevent shortfalls.

System design and acquisition seeks to maximize the performance of military systems by ensuring that humans can operate and maintain them effectively. System operators must detect, track, and target adversaries despite stress, information ambiguity, and platform motion. Maintainers function in similarly challenging environments. The true capability of the human-machine system depends not only on the performance of each component but also on the interface between them. System design should conform to an operator's or maintainer's abilities under stress. Acquisition, therefore, should reflect empirically based knowledge about ergonomics and human decision making, cognitive processing and sensory capabilities.

Requirements

Underlying the strategic vision for manpower and personnel are 9 top-level warfighting functional requirements (prioritized):

1. **EXTRACT CRITICAL INFORMATION UNDER COMPLEX AND UNCERTAIN TACTICAL CONDITIONS.**
2. **IMPROVE ABILITY TO MANAGE THE PERSONNEL FORCE STRUCTURE EFFICIENTLY AND COST EFFECTIVELY.**
3. **DESIGN AND ACQUIRE SYSTEMS OPTIMIZED FOR HUMAN USE.**
4. **PLAN COMPLEX MISSIONS AND MAKE RAPID, ACCURATE TACTICAL DECISIONS.**
5. **ATTRACT AND RETAIN HIGH-QUALITY PERSONNEL..**
6. **CONTROL AND MAINTAIN COMPLEX WARFIGHTING SYSTEMS.**
7. **IMPROVE SELECTION OF PERSONNEL AND THEIR CLASSIFICATION TO JOBS.**
8. **IMPROVE DON'S CAPABILITY TO OPTIMIZE PERSONNEL DETAILING AND ASSIGNMENT DECISIONS.**
9. **MAINTAIN OPTIMAL PERFORMANCE IN EXTREME ENVIRONMENTS AND UNDER ADVERSE CONDITIONS.**

These requirements align with the three thrust areas as follows:
- Force management
  --Improve ability to manage the personnel force structure efficiently and cost effectively.
  --Attract and retain high-quality personnel.

--Improve the selection of personnel and their classification to jobs.

--Improve DoN's ability to optimize personnel detailing and assignment decisions.

- Performance enhancement

  --Extract critical information under complex and uncertain tactical conditions.

  --Plan complex missions and make rapid, accurate tactical decisions.

  --Maintain performance in extreme environments and under adverse conditions.

- System design and acquisition

  --Design and acquire systems optimized for human use.

  --Control and maintain complex warfighting systems.

Table 10 lists prioritized goals and objectives under each of the nine top-level warfighting functions. These goals and objectives represent S&T requirements for Manpower and Personnel. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. For reference, Appendix 10 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions. (Table 10 contains no CTI column because fleet CINCs did not identify any CTIs related to manpower and personnel.)

TABLE 10. MANPOWER AND PERSONNEL: PRIORITIZED S&T REQUIREMENTS

1. EXTRACT CRITICAL INFORMATION UNDER COMPLEX AND UNCERTAIN TACTICAL CONDITIONS.	Quartile
a. **Increase operator/decision maker's ability to comprehend voluminous data.**	I
(1) Provide decision maker with capability to comprehend an order of magnitude more information with 50% fewer people.	
b. **Increase the operator/decision maker's ability to understand the tactical picture from sparse and ambiguous data.**	I
(1) Enhance tactical situation awareness by a factor of two given the same information and the same time.	
c. **Increase the operator/decision maker's ability to detect, recognize and identify targets rapidly and accurately.**	I
(1) Accomplish detection, recognition and identification at 1/10 the current error rate and in 1/2 the time.	

d. Achieve fully automated database management of tactical track data.   I

    (1) Improve database management (DBM) track correlation algorithms to permit hands-off correlation or ambiguity resolution both afloat and ashore.

    (2) Establish on-line databases that auto-fill track attributes once a contact is identified.

    (3) Establish systems/procedures for on-line / over-the-air database updates.

    (4) Make all special investigation (SI) and general service (GENSER) track data available afloat and ashore.

2. IMPROVE ABILITY TO MANAGE THE PERSONNEL FORCE STRUCTURE EFFICIENTLY AND COST EFFECTIVELY.	Quartile

a. Improve DoN's ability to rapidly determine accurate, affordable manpower requirements.   I

    (1) Develop manpower engineering tools to enhance the manpower requirements determination process.

b. Improve DoN's ability to conduct personnel management in a changing environment.   I

    (1) Develop personnel management tools to enhance executive decision making.

    (2) Increase skills transfer, reduce involuntary losses due to overmanning, and reduce personnel replacement costs.

    (3) Develop the tools to forecast and manage the impact of personnel issues associated with women and minorities in DoN.

c. Integrate DoN active, reserve and civilian manpower and personnel management systems.   I

    (1) Develop means for communication and /updating of manpower and personnel management systems

    (2) Improve the ability to respond to contingencies in a timely fashion with a trained active/reserve/civilian/contractor force mix.

3. DESIGN AND ACQUIRE SYSTEMS OPTIMIZED FOR HUMAN USE.	Quartile

a. Increase emphasis on human performance in design and acquisition process.   II

    (1) Develop and incorporate system standards, design criteria and tools based upon a human-centric focus developed from high fidelity human-performance models, research databases and simulations.

    (2) Incorporate redundancy.

    (3) Incorporate parallelism.

    (4) Incorporate fault tolerance.

    (5) Incorporate reconfigurability in fielded systems.

4. PLAN COMPLEX MISSIONS AND MAKE RAPID, ACCURATE TACTICAL DECISIONS.	Quartile
a. Improve ability of planners to understand ambiguous tactical situations, including nontraditional warfare and operations other than war. (1) Create an adaptable C^4I organizational structure that can respond to a crisis within one day.	I
b. Improve capability to plan complex missions. (1) Define mission and select course of action (COA) in less than one day.	I
c. Improve the ability of individuals and teams to coordinate with geographically distributed organizations. (1) Provide capability to operate as well while geographically dispersed as if in same room.	I
d. Eliminate decision biases.	II

5. ATTRACT AND RETAIN HIGH-QUALITY PERSONNEL.	Quartile
a. Achieve optimized use of recruiting resources. Identify and target at the individual level (recruit candidates). (1) Model/predict changes in recruit candidate behavior.	I
b. Develop the capability to predict and manage retention. (1) Model/predict changes in retention.	III

6. CONTROL AND MAINTAIN COMPLEX WARFIGHTING SYSTEMS.	Quartile
a. Reduce platform and system manning, selection and skill requirements. (1) Increase use of robotics and teleoperated systems.	III
b. Improve operator's ability to control all elements of platform and weapon systems. (1) Reduce complexity. (2) Increase procedural consistency. (3) Ensure that interfaces are fully compatible with human attributes.	IV
c. Reduce system logistics requirements. (1) Increase component commonality. (2) Reduce diagnosis and repair time by 2/3.	IV

7. IMPROVE THE SELECTION OF PERSONNEL AND THEIR CLASSIFICATION TO JOBS.	Quartile

a. **Increase DoN's ability to identify individuals with critical skills and aptitudes for highly demanding jobs.**   **III**
   (1) Develop the ability to match personnel skills to job requirements.
   (2) Reduce first-term attrition and training failures due to misclassification.

8. IMPROVE DON'S ABILITY TO OPTIMIZE PERSONNEL DETAILING AND ASSIGNMENT DECISIONS.	Quartile

a. **Empower the constituent in the assignment decision-making process within readiness, career and fiscal constraints.**   **II**
   (1) Develop distributed decision support systems to achieve goal.

b. **Permit assignment policy makers to assess strategic policy tradeoffs and feasible achievement levels in advance of assignment execution.**   **II**
   (1) Develop decision support systems to achieve goal.
   (2) Develop a tool to more effectively manage Permanent Change of Station decisions.

c. **Integrate the distribution system with the manpower and personnel system.**   **II**

d. **Provide detailers/monitors with comprehensive, effective policy guidance.**   **IV**
   (1) Improve responsiveness to multiple policies affecting assignment decisions.
   (2) Develop expert systems for a dynamically changing rule base.

9. MAINTAIN PERFORMANCE IN EXTREME ENVIRONMENTS AND UNDER ADVERSE CONDITIONS.	Quartile

a. **Enhance the ability of personnel to maintain performance levels while operating in stressful environments.**   **III**
   (1) Maximize performance under high workload, sustained operations, temperature extremes, fatigue and boredom.
   (2) Reduce operator workload through adaptive automation.

Chapter 11

Training

Strategic vision: Enable naval, joint or combined mission readiness by providing the best-trained individuals and teams. Training will be adaptable, responsive, global, efficient and consistent.

Definition and Scope

As defined for the Joint Mission Area / Support Area assessment, training includes facilities, equipment, services and instructors employed in accession training, specialized skill training, undergraduate flight training and Navy and Marine Corps education programs to maintain fleet and shore-establishment readiness. For the purpose of identifying S&T requirements through the round tables, the definition was clarified to include simulation for training and mission-rehearsal.

This technology area focuses on the development, conduct, and management of instructional programs and on the development of simulators, training devices and other training systems. It addresses professional skills required for career progression and technical abilities required for job performance; individual job skills and unit collective tasks; instruction in procedures, tactics and the operation and maintenance of military equipment; and shore-based classroom training as well as on-the-job, on-board and embedded training. It encompasses basic entry training, initial and specialized skills training, fleet training for individuals and teams, and leadership training.

Functional Description

The objective of this technology area is to provide tools and techniques to develop, in peacetime, warfighting skills approaching those of combat-experienced military personnel.

Readiness--the ability to conduct prompt and sustained military operations wherever necessary--clearly depends upon human performance in combat and combat support. DoN's training establishment provides fleet commanders-in-chief and shore support commanders with personnel qualified to carry out their naval mission assignments. To respond to a dynamic world political climate, the Navy must remain flexible despite downsizing. This requires the ability to train rapidly and effectively and to make timely changes to training methods and materials.

As the Navy becomes smaller, so does its training establishment, which must remain highly capable and committed to quality. It must support the fleet by developing individual and team skills, by enhancing sailors' understanding of Navy roles and missions, by fostering leadership, and by teaching joint doctrine throughout the training process.

To develop and sustain warfighting skills without direct combat experience, DoN must start with capable individuals, give them effective training, and then provide opportunities to develop teamwork, judgment and discipline. The process must impart expert knowledge, prevent skill degradation, assess performance and remedy shortfalls. We must be able to deliver effective training in dispersed geographic areas, in a variety of environments and at an affordable cost.

Requirements

Underlying the strategic vision for naval training are nine functional requirements (prioritized):

1. **EVALUATE/ASSESS PERFORMANCE.**
2. **DEVELOP STRATEGIES.**
3. **DELIVER INSTRUCTION.**
4. **DEVELOP INSTRUCTIONAL MATERIALS.**
5. **PROFICIENCY.**
6. **MANAGE RESOURCES.**
7. **DETERMINE REQUIREMENTS.**
8. **PROVIDE FEEDBACK.**
9. **INTEGRATE TRAINING ISSUES.**

Table 11 lists prioritized goals and objectives under each of the nine top-level warfighting functions. These goals and objectives represent S&T requirements for Training. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. Consolidated fleet Command Technology Issues (CTIs) map to round table-generated S&T requirements by alphanumerics in the "CTI" column. The alphanumerics refer to Training-related paragraphs in the CTIs, published verbatim in Appendix 11. For reference, Appendix 11 also contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions.

TABLE 11. TRAINING: PRIORITIZED WARFIGHTING FUNCTIONS AND REQUIREMENTS		

1. ASSESS INDIVIDUAL / TEAM / UNIT PERFORMANCE TO ENSURE TRAINING EFFECTIVENESS	Quartile	CTI
a. Correlate changes in training to changes in fleet readiness. Develop:	I	
(1) Methods to assess postgraduate skill competency.		
(2) Quantitative training measures of effectiveness for all levels from individual operator and decision maker to battlegroup commander.		
(3) Valid fleet-readiness models.		

b. Improve DoN's capability to evaluate training. Provide: **III**
  (1) Methods to evaluate individual and group performance.
  (2) Methods to evaluate instructor performance.
  (3) Methods to rate course/exercise effectiveness.

2. DEVELOP EFFECTIVE TRAINING STRATEGIES	Quartile	CTI

a. Innovate and optimize instructional approaches (on-demand/just-in-   **I**   **11-A**
time training) for initial, replacement, refresher and joint training.
  (1) Develop training based on a common tactical picture.
  (2) Combine real-life training with realistic simulation and stimulation.
  (3) Examine methodologies (technologies, media options), conduct cost-
      benefit analyses, and assess applicability to specific instructional
      goals.
  (4) Advance technologies (e.g., virtual reality) to make simulation more
      realistic.
  (5) Develop improved techniques to support embedded training.

3. DELIVER INSTRUCTION WHEN & WHERE MOST EFFECTIVE	Quartile	CTI

a. Optimize student/team instruction in schools, on the job, and at   **I**
remote sites.
  (1) Provide techniques to deliver effective training anywhere/on demand.

b. Enhance ability to provide individual and group training and mission   **II**
rehearsal.
  (1) Maximize student comprehension and retention.
  (2) Provide deployable training systems.
  (3) Optimize student/instructor interface.
  (4) Optimize balance and interface between shore and fleet training.

c. Provide capability for realistic, large-scale naval/joint tactical   **II**   **11-A**
training.
  (1) Link wide range of geographically dispersed units, platforms, weapon
      systems, models, simulators and databases to exercise all elements.
  (2) Maximize performance under highly stressful conditions.
  (3) Provide timely post-ex evaluation / diagnostic feedback to all hands.
  (4) Provide for rapid development/modification of complex scenarios.
  (5) Increase interoperability for joint training.
  (6) Develop techniques for brigade (BG)- and joint task force (JTF)-level
      simulation/stimulation.

4. DEVELOP EFFECTIVE, ADAPTABLE INSTRUCTIONAL MATERIALS	Quartile	CTI
a. Optimize development and maintenance of instructional materials.	II	

    (1) Develop techniques for task analysis, objective setting, media selection, curriculum development, and effectiveness measurement.
    (2) Improve authoring of instructional materials.
    (3) Reduce reliance on paper-based technical and training materials.
    (4) Develop dynamic, real-time life-cycle management of materials.
    (5) Ensure adaptability to advancing technology and methodology.

5. MAINTAIN JOB PROFICIENCY OF INDIVIDUALS / TEAMS / UNITS	Quartile	CTI
a. Develop evaluation criteria and diagnostic techniques.	I	
b. Provide strategies, tools and techniques for proficiency maintenance.	I	
c. Combine real-life training with realistic simulation or stimulation.	I	11-A 11-B 11-C

6. MANAGE TRAINING RESOURCES FOR MAXIMUM RETURN ON INVESTMENT	Quartile	CTI
a. Enhance instruction's affordability and cost effectiveness	II	

    (1) Reduce acquisition and life-cycle costs of all training devices.
    (2) Reduce the need for technical training equipment in schools.
    (3) Increase use of off-the-shelf components, adaptable simulations, predictive modeling, reusable software and innovative techniques.
    (4) Improve scheduling, management and utilization of training resources.
    (5) Augment exercises with realistic simulation/stimulation.

	Quartile	CTI
b. Develop strategies and techniques for training-resource planning, programming, budgeting and execution.	II	

    (1) Provide tools to assess trade-offs and to integrate consideration of funding, infrastructure, equipment and manpower/end-strength.

	Quartile	CTI
c. Develop modeling and simulation capabilities that predict the life-cycle costs of alternative system designs.	II	

7. DETERMINE TRAINING REQUIREMENTS	Quartile	CTI

a. Perform needs analysis.   **I**
  (1) Obtain subject-matter/fleet input.
  (2) Validate requirements.
b. Develop improved concepts for initial, replacement, refresher and   **I**
  joint training.

8. PROVIDE FEEDBACK ON TRAINING EFFECTIVENESS	Quartile	CTI
a. Develop feedback system that identifies training shortfalls. Provide:	**III**	

  (1) Validated input/output criteria for training effectiveness.
  (2) An effective, timely mechanism for fleet feedback on training.

9. INTEGRATE TRAINING ISSUES WITH OTHER PROCESSES AND POLICY:	Quartile	CTI
a. Integrate training issues with:	**IV**	**11-A**

  (1) Manpower policies/requirements
  (2) Personnel policy and distribution.
  (3) Acquisition policy and processes.
  (4) Naval doctrine and tactics.

Chapter 12

Medical

Strategic vision: Maximize health , safety and mission performance by providing optimal global medical responsiveness for prevention, protection, diagnosis and treatment.

Definition and Scope

Although the topic of medical technology found no logical and workable niche in the Joint Mission Area / Support Area structure, it is important to be addressed by the round table process. A separate Medical S&T round table was therefore established to deal with such issues as preventive medicine, mission-related medical issues, and combat casualty care.

Functional Description

As the structure and composition of the Navy changes, so does the mission of Navy medicine. Traditional roles have centered around supporting the combat readiness of the Navy and Marine Corps by supporting global medical requirements to accomplish the missions. As the nature of deployment for combat troops changes, so must medical support. Increased emphasis on preventive medicine practiced on collective and individual levels, the increasing importance of aerospace medicine, human factors and human capabilities questions in relation to new weapons and platforms were included in the scope of this year's round table process. Identifying S&T requirements through the round table process yielded a larger volume of interest areas than previously considered.

The objectives of this technology area are to maximize health, safety and mission performance of military personnel. Navy medicine encompasses aspects of medical practice from basic research to mass casualty treatment. From pure research to battlefield medicine of the most basic nature, medical developments affect the capability of Navy personnel to accomplish the mission. The S&T round table considered many areas within the strategic vision domain, as defined in the early stages of the round table process. After review of the FY 94 medical functional architecture, other medical requirements were added to complete a list relevant to current needs. This list, comprising eight war fighting functions pertaining to medicine, spans the traditional areas of concern and calls for consideration of areas in development or restructure.

Requirements

Underlying the strategic vision for medicine are eight warfighting functional requirements prioritized as follows :

1. **INDIVIDUAL AND COLLECTIVE HEALTH PREVENTATIVE MEDICINE IN NAVAL OPERATIONS.**
2. **AEROSPACE MEDICINE.**
3. **CROSS-PLATFORM NAVAL MEDICAL ISSUES.**
4. **EXPEDITIONARY FORCE (FMF) MEDICINE.**
5. **UNDERSEA MEDICINE.**
6. **SURFACE MEDICINE.**
7. **SPECIAL OPERATIONS WARFARE MEDICINE.**
8. **COMBAT CASUALTY CARE (PRESERVE HUMAN LIFE AND MANPOWER ASSETS).**

Table 12 lists prioritized goals and objectives under each of the eight top-level warfighting functions. These goals and objectives represent S&T requirements for Medical. Priority is indicated by a Roman numeral in the "Quartile" column; I, II, III and IV indicate high to low priority from an S&T investment viewpoint. For reference, Appendix 12 contains the round table-generated functional architecture, which provides detail about the components of top-level warfighting functions. (Table 12 contains no CTI column because fleet CINCs did not identify any CTIs related to medical functions.)

TABLE 12. MEDICAL: PRIORITIZED S&T REQUIREMENTS

1. INDIVIDUAL AND COLLECTIVE HEALTH PREVENTATIVE MEDICINE IN NAVAL OPERATIONS.	Quartile
a. Improve identification/prevention of new or reemerging military relevant diseases. (1) Improve prediction/prevention of military relevant infectious diseases.	I
b. Determine effect of military work patterns on chemical, biological, & physical agent exposure.	I
c. Determine the optimal physical fitness profiles for naval service.	I
d. Identify and evaluate reproductive hazards.	I
e. Develop potable water contamination indicator technology.	I
f. Improve toxicological tools for analysis of Navy specific hazardous materials.	I

g. Characterize shipboard and other platform electromagnetic environments. **I**

h. Improve surge capability in vaccines and immunizations. **II**

i. Develop expert systems for evaluation of workplace surveillance and monitoring. **II**

j. Improve shipboard ventilation for environmental quality and disease detection. **II**

k. Improve measures and quantification of RF and microwave energy absorption humans. **II**

l. Improve prevention /identification of persons at risk for adverse psychological responses. **III**

m. Develop treatment protocols for laser eye injuries. **III**

n. Determine permissible exposure limits for naval fuels. **III**

2. AEROSPACE MEDICINE	Quartile
a. Reduce human factors risk to aviation personnel	I

    (1) Identify common human factors associated with aviation mishaps.
    (2) Develop predictive model of human error in aviation mishaps.
    (3) Develop user accepted means to prevent Controlled Flight into Terrain (CFIT).
    (4) Assess and validate existing programs of Aviation Human Factors Review (Human Factors Boards, Human Factors Councils).
    (5) Develop visual scan patterns as index of pilot skill development.
        (a.) Optimize pilot visual scan performance.
    (6) Develop deployable human impairment testing systems.
    (a) Improve cognitive performance monitors in flight operations.
    (b) Automatic pilot physiological monitoring.
    (7) Develop human factors aspects of virtual environment displays used in naval aviation.
        (a) Human factors aspects of helmet mounted displays
        (b) Human factors aspects of mission rehearsal.
        (c) Voice recognition/activation.
    (8) Reduce risk to aviation flight deck/flight line personnel.
        (a) Develop methods to reduce risk on flight decks/flight lines.
            (*1*) Develop non-pharmacological countermeasures to fatigue.
            (*2*) Provide fleet with shift work scheduling alternatives.
        (b) Identify risk to flight deck/flight line personnel.

b. Improve visual performance using multi-spectral devices. I
    (1) Identify basic physiological and performance effects of electro-optic devices (including helmet mounted devices).
    (2) Improve field-of-view and resolution.
    (3) Laser/agile laser eye protection.
    (4) Light weight and user friendly.
    (5) Reduce visual distortion.
    (6) Fully integrated performance of all the above with CBR protection.

c. Increase situational awareness/spatial orientation among aviation personnel to reduce aircraft mishaps. I
    (1) Provide method to screen for susceptibility to spatial disorientation.
    (2) Provide advanced training program for spatial orientation.
    (3) Provide alternative methods for spatial orientation.
        (a) Develop methods to enhance somatosensory inputs (e.g. vibro-tactile vest).
        (b) Investigate use of artificial horizons.
    (4) Apply psycho physical and neuropsychological approaches to spatial orientation.
    (5) Optimize countermeasures for air sickness and simulator sickness.
        (a) Validate existing Navy motion sickness desensitization program.
        (b) Determine etiology.

d. Improve and validate current medical criteria for Naval aviation duty. I
    (1) Validate medical screening criteria for aviation duty.
    (2) Develop mechanism for evaluation of effects of therapeutic drugs on air crew performance.
        (a) Validate medications considered for use while flying.
    (3) Develop validated mannequin/engineering model for cockpit development.
        (a) Develop anthopometric requirements for ejection.
        (b) Provide gender specific requirements for ejection.
        (c) Provide anthropometric requirements for cockpit.
        (d) Provide necessary cockpit ergonomic modifications for females.
        (e) Reduce neck and back strain in combat aviators.
    (4) Develop next generation anthropometric criteria.
    (5) Develop gender neutral occupational strength standards.

e. **Maximize form, fit and function of personnel flight equipment for protection for environmental stresses (G's, thermal, noise, laser, CBR etc.)**   **I**
   (1) Lightweight and user friendly (helmets, boots CBR gear)
   (2) Develop lightweight, user-friendly, and reusable Military Operational Protective Posture (MOPP) gear.
   (3) Enhance hearing protection for high noise aviation environments.
   (4) Comfortable and lightweight cold water protection.
   (5) Comfortable and lightweight heat stress protection.

f. **Determine the partial pressure schedules/effects for high altitude, high G positive pressure oxygen.**   **III**
   (1) Develop schedules for repetitive altitude exposures.

g. **Develop gender/race neutral crew selection.**   **III**
   (1) Develop computer based Aviation Selection Test Battery.
   (2) Validate computer based psychomotor testing (CBPT).

3. CROSS-PLATFORM NAVAL MEDICAL ISSUES	Quartile
a. **Develop single dose multivalent vaccines for operationally relevant diseases.**	I

b. **Improve visual performance using multi-spectral devices.**   **I**
   (1) Identify basic Physiological and performance effects of electro-optical devices.
   (2) Laser/agile laser eye protection.
   (3) Improve field of view and resolution.
   (4) Lightweight and user friendly.
   (5) Fully integrated performance of all of the above with CBR protection.
   (6) Reduce visual distortion.

c. **Improve management of operational casualties.**   **I**

d. **Identify issues associated with women at sea.**   **I**
   (1) Evaluate epidemiological data and provide tools regarding medical impact of women at sea.

e. **Identify issues associated with women in aviation.**   **II**
   (1) Provide user-accepted urinary collection devices.
   (2) Establish impact acceleration limits for females (cadavric studies).
   (3) Reproductive hazards (esp. noise/vibration and ionizing/non ionizing radiation.
   (4) Ejection escape induced hazards.

f. **Develop training simulator for medical practitioners.**   **II**

g. Minimize thermal effects on human physiology (undersea, aerial, surface). II

h. Improve capability of shipboard and field anesthesia machines. II

i. Simplify laboratory procedures for independent duty corpsmen. II

j. Develop countermeasures for performance degradation during sustained operations. II
(1) Investigate pyscho-physiological effects of countermeasures.

k. Develop reagents with longer shelf lives, reduced refrigeration requirements. II

l. Improve predictive mechanics of psychological/sociological/medical adaptability & screening for special duties. II

m. Evaluate effects of photo refractive keratectomy on mission specific performance. III

n. Investigate the use of simulators to enhance physiological training for all personnel. III

o. Determine optimum fluid resuscitation as a function of time to definitive surgical intervention. III

p. Improve prevention and treatment of dental emergencies. IV

4. EXPEDITIONARY FORCE (FMF) MEDICINE.	Quartile
a. Improve potable water contamination detection technology.	I
b. Develop lightweight, user-friendly and reusable MOPP gear.	I
c. Improve Aeromedical Evaluation capability from deployed units afloat and ashore.	I

d. Optimize physical fitness programs to sustain/enhance performance. I
(1) Eliminate injuries due to physical fitness programs.
(2) Develop alternative recruit physical training requirements.
(3) Develop alternative recruit physical training programs.

e. Develop early detection and location capability of personnel incapacitation and injury. II

f. Develop an orally administered insect repellent. II

g. **Investigate use of aircraft simulators to enhance physiological training for all air crew.** II

5. UNDERSEA MEDICINE.	Quartile

a. **Develop methods to decrease/treat decompression sickness.** I
   (1) Identify basic mechanisms of decompression sickness.
   (2) Increase multi-level repetitive diving duration and decrease decompression requirements.

b. **Develop methods to predict/prevent oxygen toxicity** II
   (1) Identify mechanisms of oxygen toxicity.

c. **Identify contaminants and their effects in closed space environments.** II

d. **Minimize effects of thermal stress in immersion.** II

e. **Identify the effects and develop protection for low frequency sound in water.** III

f. **Optimize work-sleep cycles associated with submarine service.** III

g. **Identify and resolve adverse effects related to disabled submarine scenarios.** IV

6. SURFACE MEDICINE.	Quartile

a. **Improve battle dressing station and medical department equipment; improve exam tables, including accommodation of females.** I

b. **Improve mass casualty management (to include war game modeling and simulation).** II

c. **Provide filmless, digitized, x-ray capabilities for all Naval vessels.** II
   (1) Provide small, sturdy x-ray unit for service aboard serviced vessels with independent duty corpsmen (IDC).

d. **Shipboard manufacture of parenteral fluids.** II

e. **Improve on-hull communications and information management in the medical facility.** II

f. **Provide medical O_2 manufacture capability for all Naval vessels.** III

g. **Evaluate validity of color vision requirements for shipboard personnel.** IV

7. SPECIAL OPS WARFARE MEDICINE (SEALS, EOD, MARINE RECON).	Quartile
a. Define and provide optimal medical care in special warfare scenarios.	III
b. Optimize unaided and aided night vision in special operations missions.	III
c. Improve MOPP gear.	III
d. Minimize effects of changes in environmental or physical conditioning on special warfare performance.	III
e. Integrate O_2 and CO_2 machine sensors with human sensors for multi-level diving.	III
f. Laser protection under all special warfare diving scenarios.	II
g. Develop training system to support sustainment training of special operations forces.	II
h. Improve medical translator capabilities for special warfare use.	IV
i. Minimize effects of special warfare training on operational readiness.	IV
j. Define nutritional requirements to maximize special warfare performance.	IV

8. COMBAT CASUALTY CARE (PRESERVE HUMAN LIFE AND MANPOWER ASSETS).	Quartile
a. Real-time, in-situ portable life sign monitor.	III
b. Remote sensing of medical data (vital signs monitor).	III
c. Greater availability of blood and blood substitutes.	III
d. Minimize thermal effects on human physiology.	III
e. Effective battle shock prophylaxis treatment.	IV
f. Increase shelf life of resuscitative blood products.	IV
g. Eliminate logistic burden for refrigerated storage.	IV
h. Develop therapy for musculoskelatel injuries.	IV

i. **Effective battlefield treatment for hypovolemic shock.**   IV

j. **Rapid non-invasive blood chemistry monitoring.**   IV

k. **Rapid wound healing and debridement.**   IV

l. **Develop organ replacement therapy.**   IV
   (1) Skin transplants for burns.
   (2) Traumatic single organ failure.

m. **Reduced bulk fluid resuscitation technology.**   IV

n. **Eliminate immunoreactivity in emergency transfusion.**   IV

o. **Develop stem cell transfusion therapy.**   IV

p. **Improve therapy of reperfusion injury.**   IV

q. **Increase reconstitution throughput of blood products.**   IV

r. **Enzymatic conversion to O-type blood.**   IV

s. **Compact organ replacement/support systems capability.**   IV

Appendices

Each chapter in the Science and Technology Requirements Guidance has a corresponding appendix that provides background or explanatory material. Most appendices contain two items: Command Technology Issues (CTIs) and the functional architecture developed during the S&T Round Tables. The CTIs reflect input from Fleet CINCs regarding requirements for S&T investment. The architectures outline capabilities associated with warfighting functions.

Appendix 1

Joint Strike Warfare

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES

OCTOBER 1994

JOINT STRIKE WARFARE

1-A COMMON/CONSISTENT TACTICAL PICTURE (HIGH Priority)

Current systems cannot collect and fuse all-source tactical information from Navy, Joint, Allied and Coalition sources. This results in a foggy overall tactical picture. All elements of this picture, including primary collection, fusion and dissemination architecture, deconfliction, classification, broadcast, and display technologies are critical. The architecture for pulling this picture together is a major system engineering challenge, and should include all sensor platforms (air-surface, submarine and space) and two-way information sharing. Any such system must be reliable, robust and secure for effective command and control. Naval forces cannot play in the joint arena without it. The requirement is for improved reliability for all communication channels, including those connecting Navy, Joint, NATO and other coalition partners.

1-B TARGETING/BATTLE DAMAGE ASSESSMENT/COMBAT I.D. (HIGH Priority)

Recent conflicts have required threat identification beyond visual range. Rules of engagement (ROE) in the Arabian Gulf require two independent methods of positive target identification. In may cases, air crews are forced to use visual or TV sightings to confirm an aircraft is not friendly or is a noncombatant, thus limiting long-range anti-air missile use to daytime with clear skies. Without long-range, cooperative and noncooperative, positive target identification capability, air crews cannot use their long-range missiles effectively. Targeting decisions require BDA as requisite input. BDA in the tactical time frame is required for mission planning, attack and re-attack assessments. The unmanned airborne vehicle (UAV) provides an essential tool for tactical reconnaissance, targeting and BDA. Improvements in technologies such as digital imagery and transmission can make the UAV more valuable. Low-cost UAVs that can be launched from small surface combatants are required to provide basic surveillance, targeting and BDA data.

1-C ADVANCED STANDOFF WEAPONS (HIGH Priority)

Smarter weapons are essential to improved mission capability and aircraft survivability. They must be released outside the range of point defense envelopes and attain "one weapon released equals one target destroyed" criteria. Incorporating precision navigation, new/improved sensors and onboard sensor data fusion will improve weapon lethality and shooter survivability. Smart air-to-ground munitions and improved TLAMs are examples, Such weapons should include the ability to reconfigure and retarget post-launch. Ships also need new weapons for this environment. For instance, platforms like AEGIS or SSNs require more flexible weapons than Harpoon anti-ship missiles and MK-48 torpedoes when dealing with small combatants or recalcitrant merchants.

1-D ENHANCED AIRCRAFT / AIR CREW SURVIVABILITY (HIGH Priority)

Battlespace dominance in the littoral requires air superiority. Dazzling/damaging lasers pose a threat to the required air superiority. Protection against single-line and frequency-agile lasers,

short/long pulse or continuous wave, is a requirement. Additionally, protection for air crews from NBC attack requires significant improvements in the protective equipment provided to air crew and maintenance personnel. Finally, improved aircraft design and introduction of new materials have allowed aircraft performance capabilities to outpace that of human ability to withstand flight stresses. Improved flight suits and flight control aids are required to maintain air crew safety during maximum aircraft performance.

JOINT STRIKE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
PRECISION ATTACK	
Standoff Weapons	I
Ship-launched	
Submarine-launched	
Air-launched	
Sensors to Support Standoff Weapon Delivery	
Time-critical Targets	I
Data Links	I
OTH Targeting, Guidance, And Control	
Unconstrained Operations	
Anti-jam	
Man-in-the-loop Compatible	
Interoperability	
LPI	
Range	
Third-party Weapons Control	
Secure	
Lethality	I
Increased Pk Warhead	
Multi-role Warhead	
Smart Submunitions	
Enhanced Penetration	
Smart Fuses	
Accurate Targeting	I
Real Time Re-targeting	
Relocatable	
Mobile	
Autonomous	
Fixed	
Controlled Collateral Damage	
Man-in-the-loop	

PRECISION ATTACK (CONT.)

Seeker Performance   I

    Autonomous Target Recognition
    Detection, Acquisition And Tracking
    All Weather
    Lock-on After Launch (LOAL)
    Autonomous Aim Point Selection
    Off Bore Sight
    Clutter
    Counter LO / Camouflage & Decoy

Combat ID of Ground / Surface Targets   I

    Friendly
    Hostile
    Type (Threat / Non-threat)
    Neutral

High First-pass Pk   II

Weapons / Platform Interface   II

    Accurate Targeting (Fixed, Relocatable, Mobile)
    Combat ID
    BDI
    Connectivity and Communication
    Light Weight
    Blended Body / Low Observability

All Environments   II

    Weather
    Countermeasures
        Camouflage, Concealment, Deception
        Anti-jam / Anti-spoof
        Active Countermeasures
    Night
    Battle Effects
    Day
    Seasonal
    Terrain

Land / Sea Capability   II

PRECISION ATTACK (CONT.)
    SEAD   **III**

        Aim Point Selection
        Preemptive
        Non-cooperative Targeting
        Persistent
        Counter Emitter Shut Down
        Reactive
        Specificity
    BDA / BDI from Weapons   **III**
    Timely Intelligence   **IV**
        To User
        From User
    NBC Material Defeat   **IV**

TARGETING / FIRE CONTROL
    Data Links   **I**

        OTH Targeting, Guidance, and Control
        Unconstrained Communications
        Anti-jam
        Interoperability
        Range
        Man-in-the-loop Compatible
        LPI
        Third-party Weapons Control
        Secure
    Time-critical Targets   **I**
        Relocatable
        Mobile
        Fixed
    Platform Standoff Targeting   **II**
    Target Classification / Identification (For Non-combat ID)   **II**
    Accuracy (Where Is It?)   **II**
    Combat ID   **II**
        Friendly
        Hostile
        Type
        Neutral

TARGETING / FIRE CONTROL (CONT.)

    Timeliness   **III**

        Near Real Time

        Real Time

        Time Late

    Platform / Weapon Interface   **III**

        Fusion & Correlation Of All Sensor Types

        All Aspect Targeting / Cueing

        LO Carriage

    All Environments   **III**

        Identification

        Weather

        Discrimination

        Countermeasures

            Camouflage, Concealment, Deception

            Anti-jam / Anti-spoof

            Active Countermeasures

        Night

        Battle Effects

        Seasonal

        Definition

        Day

        Terrain

    Resolution (What Is It?)   **III**

    Compatibility With National Assets   **IV**

    Passive Targeting   **IV**

    Weapon / Sensor / Platform System Integration   **IV**

        Man-in-the-loop

        Autonomous

    Multi-Mission Capability   **IV**

        Precision Attack

        Anti-air

        Anti-ship

    Indication & Warning   **IV**

AIR SUPERIORITY

Missile Kinematics (Range, Maneuverability, Speed)	I
Support Standoff Weapon Engagement	II
Seeker Performance	II

    High Off Bore Sight
    Detection, Acquisition and Tracking
    Positive ID
    Lock-on After Launch (LOAL)
    Hit Confirm / Kill Confirm
    Improved CCM
    Counter LO

Weapons / Platform Interface	II

    Positive Target ID
    All Aspect Targeting / Cueing
    Fusion & Correlation of All Sensor Types
    LO Carriage

Data Links	II

    OTH Targeting, Guidance, and Control
    Anti-jam
    Unconstrained Communications
    Interoperability
    LPI
    Man-in-the-loop Compatible
    Secure
    Third-party Weapons Control
    Range

All Environment	II
Situational Awareness	II

    Indication & Warning

Air / Surface Capability	III
Lethality	III

    Increased Pk Warhead
    Fusing

SEAD Capability	III

    Counter SAM AAA

Physical Characteristics	IV

STRIKE PLATFORMS AND WEAPONS (AIRFRAME AND PROPULSION)

Aerodynamic Performance   **I**

    Agility

    Speed

    Increased Range

    Handling Qualities

Structures And Materials   **I**

    Maintainability

    Signature Management

    Lightweight

    Modular Construction

Propulsion Performance   **I**

Crew Systems   **III**

    Information Management / Human Interface

    Ingress / Egress (Get In / Get Out)

    Oxygen Generation

Crew Protection   **III**

    Laser Protection

    Survival Equipment (G Tolerance)

    Directed Energy

    CBR

SURVIVABILITY (PLATFORMS & WEAPONS)

Reduced Susceptibility (Visibility / Signature)   **I**

    Self Protection Systems

        Threat ID

        Adaptive Countermeasures

        Countermeasures Management

        Rapid Reprogramming of ELINT Libraries

    Real Time Situational Awareness

        Fusion & Correlation of All Sensor Types

        Outside Engagement Envelope Detection

        Threat Warning Systems

    Low Probability of Intercept / LO Carriage / LO Weapons

Standoff Capability (Outside Of Tactical Engagement Envelope)   **I**

Reduced Vulnerability   **II**

JOINT STRIKE MANAGEMENT
  Joint Strike Planning   **I**
      Performance Prediction
      Deconfliction
      Route Planning
      Threat Assessment
        Exploitation
      All Environment
      Threat Database
  Targeting   **I**
      Real Time Re-targeting
      Critical Nodes
      Re-targeting
  Battlespace Assessment   **II**
  Execution   **II**
      Controlling
      Monitoring
  Weaponeering   **III**
      Target Vulnerability Assessment
      Imagery
      Terrain Database
  Tasking   **IV**
      Dissemination
        Video / Imagery
        Low Data Rate
      Interactive
      Communication
  Rehearsal   **IV**
      Video / Imagery
      Controlling
      Monitoring
      Feedback
  Reporting   **IV**
      Imagery
      Debrief Fusion
      Debrief Dissemination
      Public Affairs Operations

SURVEILLANCE & RECONNAISSANCE

Sensors For Time Critical Targets   I
- Relocatable
- Mobile
- Fixed

Sensors for Combat ID   II
- Friendly
- Hostile
- Type (Threat / Non-threat)
- Neutral

Information Fusion   II
- Evaluation
- Correlation
- Integration

All Environments   III
- Weather
- Countermeasures
  - *Camouflage, Concealment, Deception*
  - *Anti-jam / Anti-spoof*
  - *Active Countermeasures*
- Night
- Battle Effects
- Seasonal
- Day
- Terrain

Information Dissemination   III
- Timeliness
  - *Response Time*
  - *Time Late*
  - *Report Frequency*
- Accuracy
- Tailored To User

Area Coverage   III
- Sustainment
- Periodicity (e.g., a day ahead)
- Footprint

Indication & Warning   III

Multi-Mission Capability   IV

TACTICAL CONNECTIVITY

Common Tactical Picture   I

Joint, Adequate, Available, & Accurate

Timeliness

Tailored to User

Access

Secure, Interoperable Voice / Data Communications   II

High Throughput

Data Links (Includes Post-Launch Weapons Control)

Anti-jam

OTH

Low Probability of Intercept

Geopositioning   II

Accuracy

Anti-Jam

Flexible, Reconfigurable, & Interoperable Architecture   III

Force Reporting

Force Interface

Command Reception

BATTLE DAMAGE ASSESSMENT

Near Real Time BDI (Operate Inside of Enemy's Decision Cycle)   I

Imagery

Data

Accuracy   III

Confidence

Confirmation

All Environments   III

Weather

Countermeasures

Camouflage, Concealment, Deception

Anti-jam / Anti-spoof

Active Countermeasures

Night

Battle Effects

Day

Seasonal

Terrain

Interpretation   IV

Functional Damage

Physical Damage

Order of Battle Update

Data Fusion

SHIP / SUB PLATFORMS-RELATED SYSTEMS
Data Links   **II**
    OTH Targeting, Guidance and Control
    Anti-Jam
    Unconstrained Operations
    Interoperability
    Third-party Weapons Control
    Secure
    Man-in-the-loop Compatible
    Range
    LPI
Improved Launch Capability   **III**
Insensitive Munitions   **IV**
Reduced Crew Requirements   **IV**
Weapons Support Systems   **IV**
Weapons Protection   **IV**
    Damage Control
    Arrangement

Appendix 2

Joint Littoral Warfare*

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

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* Refer to the classified STRG appendix, under separate cover, for classified S&T requirements.

JOINT LITTORAL WARFARE

2-A MINE WARFARE / MINE COUNTER MEASURES (HIGH Priority)

Mines present a major littoral warfare threat. MCM capabilities are required for surface, submarines, air and Naval Special Warfare forces. Landing forces need the capability to land without suffering major casualties and equipment losses by mine warfare. These forces must either avoid, neutralize or remove the mine threats. MCM C^4I capabilities are required. This C^4I requirement needs to be in a cooperative engagement format so ALL forces provide/share MCM collected information. MCM improvements include, but are not limited to: new sweeps and neutralization techniques, ship and small craft tracking system, avoidance/detection sonars and other sensors, reduced ship signature and vulnerability, methods to land without triggering mines, improved EOD mine clearance technology, trainers and simulators. Improved naval mines and mine laying capabilities are required for surface, submarine and air platforms.

2-B SHALLOW WATER ASW (HIGH Priority)

Littoral operations require mission performance in shallow water inside enemy threat envelops of surface, submarine and air forces. The mission requirement is to detect, classify, localize, attack and destroy diesel submarines in this complex environment. Improved acoustic and non acoustic sensors, processors, displays and tactical decision aids are needed. A capability to quickly identify threat submarines from neutrals and friendlies in the littorals is required. Surface and air forces require a better periscope detection capability. This is especially critical against diesel submarines which spend a great deal of time at periscope depth. An improved ASW weapon tailored for this environment is required. Submarines must have weapons which operate in the shallow water environment. Minisub defense and methods to deter covertly deployed enemy SOFs (i.e., sapper team) are required. Improved submarine navigation and depth control are required for shallow water operations.

2-C SHIP SELF DEFENSE (HIGH Priority)

All ships (especially surface ships, but including submarines) need improved self-defense capabilities against diesel submarines (periscope detection), torpedoes, small boats, cruise missiles, and floating mines. In the event damage does occur, expert ship damage control could save lives and ships. Ship systems and personnel protective clothing/equipment are needed for protection during NBC attack. Also required is a soft kill capability for incoming anti-ship cruise missiles. Current ASCM-capable systems have not been optimized for BG operations with ships close in company. Synergism between hard kill and soft kill is assumed, but inappropriate use of either can result when target information is inadequate, unclear or misjudged. Attack helicopters are required to provide surveillance and kill in littoral waters for surface ship defense. Systems such as a Smart Mast Counted Sight and multi-spectral decoys are needed. Detection systems (sensors) for littoral waters need to be fused and provide high probability of detection and validation.

2-D <u>THEATER MISSILE DEFENSE - TMD (HIGH Priority)</u>
Littoral warfare exposes CVBGs and forces deployed ashore to the TBM threat. Regional powers already possess TMD capability, including conventional warheads and Weapons of Mass Destruction (WMD). An organic capability to defeat all facets of this threat is needed, shortly after launch or before apogee. TMD also includes ASCM. Long range detection and CEC is needed, not only against the TBM, but also against long range, stealthy ASCMs.

2-E <u>NON-LETHAL (NL) WEAPONS (HIGH Priority)</u>
A NL capability is required to immobilize opposition personnel and equipment in order to neutralize and contain during initial mission phases. NL weapons are also needed during occupation to ensure minimal injury to personnel.

2-F <u>NAVAL SPECIAL WARFARE (MEDIUM Priority)</u>
Naval Special Warfare operations are an essential part of Littoral Warfare. Special Warfare forces require new covert means to interdict enemy territories. Requirements for interdiction center around: high energy density propulsion systems, stealthy platforms and advanced life support systems. These systems must have small rugged sensor fusion and C^4I capable hardware. Special Warfare forces must be able to covertly transmit collected intelligence in a timely manner. Shallow Water MCM capabilities are required. Other important requirements include: non-lethal tunable weapons, advanced sensors, target location and marking, advanced weapons and munitions, and overall weight reduction and miniaturization of equipment.

2-G <u>NAVAL SURFACE FIRE SUPPORT (MEDIUM Priority)</u>
Current NSFS systems are limited in range and types of munitions delivered. Longer ranges with increased accuracy using advanced munitions are required to support Littoral Warfare.

2-H <u>LANDING FORCES (MEDIUM Priority)</u>
Need improved night operations capabilities, medium range man-portable anti-tank weapons, covert/stealthy reconnaissance, signature reduction (including special operations equipment), and improved expeditionary airfield capabilities (light weight matting, night-ops capability and modular aircraft revetments). Improved NBC protection is required for ground personnel including protective clothing and detection systems.

2-I <u>MARITIME INTERDICTION FORCE SURVEILLANCE (LOW Priority)</u>
Recent experience in regional conflicts shows maritime interdiction is a required mission. The maritime force must possess the capability to detect, track, and monitor potential embargo violators. Boarding parties also must possess the capability to search a vessel rapidly and thoroughly, without damaging non-embargo cargoes.

JOINT LITTORAL WARFARE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
SHIP SELF DEFENSE (INCL. VERSUS SEA SKIMMER)	
Threat Detection-C3I	I
OTH Targeting-C3I	I
IFF-C3I	I
Reconfiguration-Damage Control	I
Integrated Survivability Management-Damage Control	I
Kill Assessment—FCS-C3I	I
Battlespace Surveillance (targeting and ID)-C3I	I
Directed Energy Weapons-Guns & Launching Systems	I
Sensor Fusion	I
Track—FCS-C3I	II
Hull/Structures-Survivability	II
Replenishment of Vertical Launchers (at sea reloading)-Sustainability	II
Distributed Ship Systems Architecture-Survivability	II
Intelligence-C3I	II
Precision Guided Munitions - Autonomous Target Recognition-Guns & Launching Systems	II
EO-Signature Control	II
Armor-Survivability	II
Radar Cross Section Reduction-Signature Control	II
Chem/Bio/Rad-Hardening-Survivability	II
Multispectral-Signature Control	II
Environmental TDAs-FCS-C3I	III
Sensor/Weapon Performance Prediction-FCS-C3I	III
Personal Protection-Damage Control	III
Fire Fighting/Flooding-Damage Control	III
Decoys-Engage SK	III
Propulsion-Guns & Launching Systems	III
Maneuverability-Survivability	III
Acoustic-Signature Control	III
Magnetic-Signature Control	III
Emergency Fabrication Systems-Damage Control	III
EM—Hardening-Survivability	III

Active Jammers-Engage SK	III
Chaff-Engage SK	III

SHIP SELF DEFENSE (INCL. VERSUS SEA SKIMMER) (cont.)

Laser-Guns & Launching Systems	III
IR-Signature Control	III
Emergency Power-Damage Control	IV
Sub-munitions-Guns & Launching Systems	IV
LPI RF-Signature Control	IV
Conventional Munitions-Guns & Launching Systems	IV
Wake-Signature Control	IV
EM/EO TDAs-Signature Control	IV

SHIP-TO-OBJECTIVE MANEUVER (INCL. NON-COMBATANT EVACUATION)

Sea Basing	I
Amphib Platforms-Assault Follow-on Echelon	I
Battle Damage Assessment (UAVs, TACAIR, VIP, ...)-C3I	I
OTH Targeting-C3I	I
Selective Offload-Assault Follow-on Echelon	I
Aviation-Assault Follow-on Echelon	I
Amphib Platforms-Follow-on Forces	I
Mission Planning-C3I	I
Communications Management-C3I	I
Heavy Lift-Assault Follow-on Echelon	II
Navigation Positioning Systems-C3I	II
Battlefield Surveillance (targeting and ID)-C3I	II
Intelligence-C3I	II
Amphib Platforms-Initial Assault (Opposed, Unopposed)	II
Advanced Inventory Visibility-Selective Offload-Assault Follow-on Echelon	II
Selective Offload-Follow-on Forces	II
Fire Control Systems-C3I	II
Deception	II
Aviation-Initial Assault (Opposed, Unopposed)	II
Personnel (armor, propulsion, weapons)-Initial Assault (Opposed, Unopposed)	II
Heavy Lift-Initial Assault (Opposed, Unopposed)	III
Heavy Lift-Follow-on Forces	III
Met/Ocean Forecasts-MP-C3I	III
Personnel-Assault Follow-on Echelon	III
Aviation-Follow-on Forces	III

Rapid Survey-Initial Assault (Opposed, Unopposed)	III
Bulk Supply-Initial Assault (Opposed, Unopposed)	III

SHIP-TO-OBJECTIVE MANEUVER (INCL. NON-COMBATANT EVACUATION) (cont.)

Selective Offload-Initial Assault (Opposed, Unopposed)	III
Bulk Supply-Assault Follow-on Echelon	III
Personnel-Follow-on Forces	III
Environmental TDAs-MP-C3I	IV
Bulk Supply-Follow-on Forces	IV
Advanced Inventory Visibility—Selective Offload-Follow-on Forces	IV
Advanced Inventory Visibility-Selective Offload-Initial Assault (Opposed, Unopposed)	IV

MCM: DEFENSIVE MISSION USING ACTIVE METHODS

Minehunting (Detection)	I
Minehunting (Neutralization)	I
Minehunting (Identification)	I
Minehunting (Classification)	I
Breaching	I
Minehunting (Localization)	I
Navigation/Marking/MC&G	I
Influence Sweep (Magnetic/Electric)	I
Influence Sweep (Acoustic/Seismic)	II
Influence Sweep (Pressure)	II
Explosive Ordnance Disposal (Mine Exploitation)	III
Explosive Ordnance Disposal (Ordnance Location)	III
Mechanical Sweep (Neutralize Cases)	III
Explosive Ordnance Disposal (Neutralization)	III
Mechanical Sweep (Effectiveness)	IV

ALL SOURCE DATA FUSION

Fusion Engineering (multi-sensor, multi-platforms, multi-forces)	I
Interoperability	I
High Bandwidth and High Speed Switching (Voice, Video, GHz Data Links	I
Organic to the Force	I
Timeliness - Fusion Engineering	I
Correlation - Fusion Engineering	II
Filtering - Fusion Engineering	II
Prioritization of Input - Fusion Engineering	III
Force Information Feedback - Fusion Engineering	III

Nonorganic to the Force   IV

MCM: DEFENSIVE MISSION USING PASSIVE METHODS
Mine Detection & Avoidance   I
Localizing Minefields (Reconnaissance)   I
Signature Reduction/Masking   I
Platform Hardening   III

AIR COMBAT: ENGAGE & DESTROY (OR NEUTRALIZE)
Multi-sensor Weapon   I
Highly Maneuverable Kill Capability   I
Hit to Kill   I
Terminally Maneuverable TBMs - Highly Maneuverable Kill Capability   I
Air Launched Anti-Cruise, Anti-Air, Anti-TBM Missile   I
   (multipurpose, boost phase)
Speed of Light Weapon   II
20 G missile- Highly Maneuverable Kill Capability   II
Reduced Battlespace (Time, Distance)   II
Kill Passive Homing (IR, EO, command guided)   II
Very Low Observable   II
Improved Fusing   II
Multi-purpose- Highly Maneuverable Kill Capability   II
Decoy Proof   II
Improved Explosives   II
Single Multi-Target Guided Gun Projectile (close in, small boats,   II
   sea skimmers, air, subs, mines)
Multiple Target Capability (18 in 30s)   II
10 G aircraft - Highly Maneuverable Kill Capability   III
Passive Targeting (fire control quality)   IV
Intermittent Control- Highly Maneuverable Kill Capability   IV
Passive Ranging   IV

UNDERSEA THREAT NEUTRALIZATION
Submarine (includes minis, UUVs)   I
Mines   I
Torpedoes   I
Sensors (includes portable arrays)   III

NAVAL SURFACE FIRE SUPPORT

Battlefield Surveillance (targeting and ID)-C3I	I
OTH Targeting-C3I	I
Battle Damage Assessment (UAVs, TACAIR, VIP, ...)-C3I	I
Intelligence-C3I	I
Mission Planning-C3I	I
PGM - Autonomous Target Recognition-PGM-Guns & Launching Systems	II
Response Time	II
Fire Control Systems-C3I	II
Propulsion-Guns & Launching Systems	II
Replenishment of Vertical Launchers (at sea reloading)-Sustainability	II
Operator Interface	III
Sub-munitions-Guns & Launching Systems	III
Logistics (affordability)	III
Conventional Munitions-Guns & Launching Systems	III
Navigation Positioning Systems-C3I	III
Meteorology-C3I	IV

UNDERSEA COORDINATION & TACTICAL CONTROL

Maintain Common Tactical Picture	I
Resource Assignment/Optimization	II
Mission Planning	II
Information Management	II
Human/Computer Interface	III

MINE WARFARE: C4I

Connectivity	II
Data Fusion	II
Intelligent Systems	II
Mission Planning (Tactical Theory)	II

AIR CONTACT IDENTIFICATION

Classification (including Helos)	I
Signature Characterization (all spectrum) - Classification	I
Simultaneous with Detection - Classification	I
All-Aspect Classification	I
Decoy Discrimination	II
Target Type State - Classification	III

OPERATIONS ASHORE (MARINE CORPS)

VSTOL-Tactical Vehicles	II
Integrated All Source Fused Intelligence-C3I	II
IFF/Combat ID-C3I	II
Mission Planning-C3I	II
National Theater and Tactical Imagery-C3I	II
MCM-Combat Engineering	II
Real Time I&W-C3I	II
Distributed Networking-C3I	II
Increased Survivability-Soldier Marine Enhancement	II
Air Defense	II
Obstacle Clearance-Combat Engineering	III
AAAV-Tactical Vehicles	III
BDA-C3I	III
Lighten Load-Soldier Marine Enhancement	III
Spec Op and Tactical Recon	III
Tanks-Tactical Vehicles	III
Hard Target Clearance-Combat Engineering	III
Heavy Equipment-Combat Engineering	III
Tactical Comm Systems	III
LAV-Tactical Vehicles	III
Increased Lethality-Soldier Marine Enhancement	IV
Direct--Crew Served-Ground Weapons (lethal & non-lethal)	IV
Crew Served-Ground Weapons (lethal & non-lethal)	IV
Indirect-Crew Served-Ground Weapons (lethal & non-lethal)	IV
Individual-Ground Weapons (lethal & non-lethal)	IV
Trucks >= 5 ton-Tactical Vehicles	IV
Trucks <= 5 ton-Tactical Vehicles	IV

UNDERSEA ENVIRONMENTAL ASSESSMENT

Modeling & Simulation (surface, subsurface)	I
Environmental Physics for Sensor & Weapon Design	II
Now Casting (real time environmental awareness)	II
Bathymetry, etc. (incl. high speed survey)	II
Remote Sensing	II
Oceanographic/Atmospheric Intelligence	III

AIR CONTACT DETECTION

Signature	I
Jamming	I
Unmanned Sensor Platforms (long endurance, theater surveillance)	I
Stealth Helos, UAVs, & RPVs	II
Clutter-Real Time Environmental Measurements	II
Real Time Environmental Measurements (situational awareness & weapons applicable range)	II
Propagation - Real Time Environmental Measurements	II
Covert	II
Wide Spectrum Shared Aperture	III
Intent	III
ESM	III
Environmental TDAs	IV
Virtual Aperture	IV

SURVEILLANCE OF THE UNDERSEA BATTLESPACE

Sensors	I
Sensor/Array Mechanics & Deployability	II
Processing	II
Counter Surveillance	III

OFFENSIVE MCM

Surveillance	I
Targeting Issues	II

UNDERSEA FORCE/UNIT SURVIVABILITY

Platform Defense	I
Weapon Improvements	II
Organic (each BFC) Mine Detection & Avoidance	II
Platform HM&E Survivability Initiatives	II
Weapon/Platform IFF	III
Countermeasures	III
Signature Reduction for Submarines and Weapons	III
Platform Maneuverability	III
Distributed Architecture (e.g. computers)	III
Area Denial	IV

UNDERSEA COVERT/NON-COVERT INDICATION & WARNING

Intelligence	I
Aircraft & Small, Fast Surface Craft	II
Signature Control (active & passive)	II
Special Ops Forces	III
Mining Activities	III
Low Observable (periscopes, masts, sail, etc.)	III

KNOWLEDGE OF OWN FORCES

Precise Location	I
Secure Communication	II
Intended Movement	IV

SPECIAL/UNCONVENTIONAL OPERATIONS

Chem/Bio/Laser Contaminated Environment Capabilities	II
Equipment Handling During Launch & Recovery Ops	II
Clandestine VSW Mine Recon and CM	II
Portable Real Time Intel Gathering and Transmission	II
Information Management-Systems & Computer Technology	III
Improved Power Sources	III
LPI and LPD Comms	III
Positioning & Navigation	III
Signature Reduction	III
Enhanced Destructive Power-Non-attributable Munitions	IV
Training Ammo-Non-attributable Munitions	IV
Simulation-Systems & Computer Technology	IV
Mission Planning-Systems & Computer Technology	IV
Training Explosives-Non-attributable Munitions	IV
Field Use-Systems & Computer Technology	IV
Underwater Breathing Apparatus	IV
Training-Systems & Computer Technology	IV

MINE COUNTER-COUNTER MEASURES

Mine Counter-Counter Measures	III

ENVIRONMENTAL PHYSICS OF MINE WARFARE

Environmental Physics of Mine Warfare	III

WEAPONS AGAINST OTHER MARITIME-SURFACE TARGETS

OTH Targeting-C3I	**II**
Fire Control Systems-C3I	**III**
Battle Damage Assessment (UAVs, TACAIR, VIP, ...)-C3I	**III**
Battlefield Surveillance (targeting and ID)-C3I	**III**
ASUW	**III**
Precision Guided Munitions-Guns & Launching Systems	**III**
Logistics (affordability)	**III**
Intelligence-C3I	**IV**
Mission Planning-C3I	**IV**
Penetrating Warheads-Guns & Launching Systems	**IV**
Sustainability (reload)	**IV**
Navigation Positioning Systems-C3I	**IV**
Propulsion-Guns & Launching Systems	**IV**
Autonomous Target Recognition-PGM-Guns & Launching Systems	**IV**
Man in the Loop-PGM-Guns & Launching Systems	**IV**
Sub-munitions-Guns & Launching Systems	**IV**
Conventional Munitions-Guns & Launching Systems	**IV**
Response Time	**IV**
Operator Interface	**IV**

AIR BATTLESPACE SURVIVABILITY

Reduced Susceptibility to Weapon Targeting (from ship)	**II**
Reduced Susceptibility to Weapon Targeting (from air)	**II**
Signature Reduction	**III**
Reduced Vulnerability to Weapon Impact (from air)	**III**
Reduced Vulnerability to Weapon Impact (from ship)	**III**
Reduced Man Power	**III**
Body Armor	**IV**
Cover & Deception	**IV**
Automated Damage Control	**IV**
Chem/Bio Protection Ships	**IV**
Towed RF Decoys - Cover & Deception	**IV**
Automated Firefighting & Protection	**IV**
Our IR Decoys - Cover & Deception	**IV**

AIRCRAFT PLATFORMS & PROPULSION

More Efficient VSTOL Propulsion	II
Improve Reliability (for reduced cost including support)	II
Lightweight Structures	III
Improved VSTOL Survivability	III
Universal Offboard Sensor Data Link	III
Detection Control, etc. Sufficient for Mixed Combat Env (Blue Air & Blue Missiles)	III
Specific Energy Improvement - Propulsion	III
Propulsion	III
Integral Passive & Active Arrays	IV
Shared Aperture	IV
More Efficient Electrical Power (Production & Consumption)	IV

REMOTE CONTROL OF MINEFIELDS

Remote Control of Minefields	III

MINE DELIVERY

Air Delivery	II
Subsurface Delivery	II
Surface Delivery	IV

AIRCRAFT EXTERNAL & INTERNAL COMMUNICATIONS

Automatic Reconfiguration	II
Voice Clarity	III
Automatic Translator	IV

MARITIME INTERDICTION (OF MERCHANT SHIPPING)

Surveillance	II
Non-Lethal Anti-Ship Weapons	II
Classification	II
Inspecting	III
Boarding	III
Tagging	IV

MINE EFFECTIVENESS

Target Localization	III
Warheads	III

ASSESSING BATTLE DAMAGE

AIRCRAFT SUSTAINABILITY

CONTROL OF AIRCRAFT SENSORS AND WEAPONS

MINEFIELD PLANNING

MINE TRAINING SYSTEMS

MINE WARFARE TRAINING SYSTEMS

Appendix 3

Joint Surveillance

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
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JOINT SURVEILLANCE

3-A RECONNAISSANCE (HIGH Priority)

A system which facilitates integration of Joint, Multi-National or Coalition reconnaissance data is required. It should be compatible with the concepts embodied in the "Common Tactical Picture" described under Joint Strike. Real-time processing of tactical reconnaissance data from manned and unmanned aircraft is an absolute necessity. Littoral Warfare requires organic real time Ground Order of Battle (GOB) definition. Improved organic surveillance capabilities are needed, including better electro-optic (EO) sensor suites and better imaging synthetic aperture radar (ISAR). Sensors are primarily intended for aircraft, but could also be placed aboard surface ships or submarines.

3-B OFF BOARD SENSORS (HIGH Priority)

(Also applies to Joint Littoral.) Off board sensors are required to increase the capability for conducting covert surveillance in a littoral warfare scenario. Sensors are needed for mine detection, identification and avoidance; wide area search and overt surveillance of diesel submarines; oceanographic surveys; and undersea BDA. Improved cost effective UUVs are required. Platforms require off board sensors that can be vectored on short notice to provide critical surveillance and targeting information. Low cost UAVs that can be launched from small surface ships are required to provide basic surveillance data. For interdiction missions, improved over-the-horizon radar is required for detection and tracking of vessels and aircraft.

3-C MERSHIP TRACKING (MEDIUM Priority)

(Also known as Specific Emitter Identification - SEI.) SEI is a promising concept for adding white shipping to the Common Tactical Picture without requiring a large investment in additional aircraft or other surveillance systems. The technical feasibility of making the SEI measurement has been demonstrated. Improved equipment, standardized databases, and better matching algorithms are needed to reduce the procedure to an operationally useful tactic. This concept also includes small craft with low profiles used in drug trafficking. Surface Search Coordination (SSC) and Force over the horizon (OTH) Track Coordination (FOTC) can be enhanced by developing a similar tactic using high frequency (HF) transmissions. The tactic should be fully automated to search, detect, parametrically classify and correlate to hull, HF ground wave transmission from MERSHIPS.

3-D IMPROVED EM/EO SENSOR PREDICTION SYSTEM (MEDIUM Priority)

(Applies to Joint Strike also.) The EM/EO spectrum provides important information about enemy deployments, order of battle (OOB), etc. EM/EO energy propagates in the wave guide of the atmosphere over the irregular boundary of the earth's surface. The combination of the variable atmospheric conditions and variable terrain creates a highly range-dependent environment that makes propagation prediction difficult, but essential. Current EM and EO

prediction systems use a single atmospheric profile, obtained from a ship at sea; this is inadequate. Operations require "volume/synoptic" sampling across the battlespace, vice "point" sampling; and a model capable of predicting EM/EO behavior across the transition from sea to land. A Tactical Decision Aid is needed that displays the geo-referenced result.

JOINT SURVEILLANCE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
TACTICAL RECON (SITUATIONAL AWARENESS)	
I&W	I
Classify and combat ID	
Positive Hostile ID	
Real Targets/Decoys	
Chem/Bio Detection	
Detect	
Geolocate	
Intent	
Tracking	
BDA	I
Functional	
Timely	
Structural	
Intel prep of the battlespace	II
Unobtrusive Sensing	
Targeting	II
Combat ID	
Geolocation	
OTH Tracking	
MOBILE TARGETS	
Wide Area View	I
Detect priority targets	
Maintain track	
Detect All Targets	
Tag Target	
Discrimination	I
Identify (whose)	
Classify (what)	
Automated Change Detection	III
Auto cueing	
Maintain track	
Tag Target	
Counter Deception	III
Identify (whose)	

Classify (what)

MINES

 Monitor Area   **I**

  In Situ Detection/Classification

   Monitoring an Area

 Identification   **II**

  In Situ Detection/Classification

   Mine type identification

 Covert Operations   **II**

  In Situ Detection/Classification

   Covert wide area detection

   Covert detection Q-route

 Mining   **II**

  Deployment

  Storage/Preparation

  Transport

 Detect and Classify   **III**

  In Situ Detection/Classification

   30' water depth to shore (and inland)

   Timely detect/classify/geolocate

   Detection of a buried mine

   Near-surface mines (at any water depth)

INFORMATION AVAILABILITY / COMPATIBILITY WITH C4I

 Timeliness   **I**

 Accuracy   **II**

 Enhanced Sensor Preprocessing   **II**

  Enhanced Sensor Preprocessing

  Timely Transmission to Initial User

   Enhanced Sensor Preprocessing

  Increased Imagery Throughput

   Enhanced Sensor Preprocessing

 Completeness   **III**

SURVEILLANCE RESOURCE MANAGEMENT

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Joint Space & Electronic Warfare / Intelligence

- **Command Technology Issues**

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JOINT SEW / INTELLIGENCE

4-A COMMON/CONSISTENT TACTICAL PICTURE (HIGH Priority)
A system which provides a common/consistent joint, multi-national, or coalition tactical picture is required. It should possess the ability to fuse all-source data, have multi-level security (including the ability to selectively pass information to different operational partners), and allow two-way transfer of information (e.g., from Navy units to JTF units). Above all, it should respond in tactical time frames. Sheer volume of message traffic requires improved communication and processing equipment.

4-B JOINT/MULTI-NATIONAL/COALITION C4I2 SYSTEM (HIGH Priority)
(See also "Common Tactical Picture.") This is a Roll On/Roll Off capability for use by hurriedly assembled coalition partners, which also would address the needs of JTFs assembled from widely dispersed units. Today's battlefield will most likely contain not only other services but other nations serving in coalition efforts, neutrals, civilians, and hostilities. The ability to adequately separate the various entities and maintain tracks and their separate identifying parameters is essential. A second facet of this capability could be a Joint Maritime Operations Command Center (JMOCC).

4-C COMMUNICATION RELIABILITY (HIGH Priority)
Reliable and secure communications are fundamental to effective command and control. Naval Forces rely on advanced, emerging communication technology to participate in joint operations. The need exists for improved reliability for all communication channels, including those connecting Navy, Joint, NATO and other coalition partners.

4-D BATTLEGROUP COOPERATIVE ENGAGEMENT EW (HIGH Priority)
(See ship self defense in the Joint Littoral also.) Optimized soft skill measures against Anti-Ship Cruise Missiles (ASCM) are needed. We need to know the effects of using EW measures on other ships at close ranges. We also need to know the effects of using multiple ECM systems simultaneously in a constrained battlespace. Optimum deployment of chaff, SLQ-32 units, unit positioning, etc., need to be known in advance for expected threat axes. A cooperative engagement EW capability is required plus an EW platform similar to the EA-6B.

4-E SECURE SUBMARINE COMMUNICATIONS (MEDIUM Priority)
Two-way communications with submarines at speed and depth is not optimum for all offensive and defensive missions. We need the capability to process bi-static active signals to support SSN/SSBN security and operate effectively while the submarine is at speed and depth. While a one-way (receive) capability is adequate for some missions, two-way communications is required. In both cases, security demands high data rate transmissions to reduce ship vulnerability and exploit the ship's stealthiness.

4-F JOINT BATTLEFIELD SIMULATION/STIMULATION (MEDIUM Priority)
Distributed network. Should provide stimulation of embedded capabilities in addition to simulation ashore (at training centers, etc.). This will allow enroute training on actual equipment, tailored to the situation at hand. Many technological issues are included in the requirement and it must be Joint and Interoperable.

4-G SHIP TO SHORE COMMS OTH (MEDIUM Priority)
Amphibious operations envision launching assaults from OTH stand-off distances. Sensors for OTH use and communications for Beyond Line-of-Sight forces are limited. Means of collecting sensor data for OTH targets and for communicating with forces that are beyond line of sight are needed. Communications must be secure, jam-resistant, voice and data capable and interoperable with joint, multi-national and coalition forces.

4-H MAPPING CHARTING AND GEODESY (MC&G) DATA DISTRIBUTION & TRANSMISSION (MEDIUM Priority)
Littoral operations may take place in unanticipated and unsurveyed areas of the world. The ability to collect and process Mapping, Charting and Geodesy (MC&G) data as quickly as possible is critical. After processing, immediate distribution to all units is required for mission planning and execution (e.g., amphibious, mine warfare, submarine operations, etc.). Such collection, processing and distribution must be digital for transmission to units afloat.

4-I COVERT TRACKING (MEDIUM Priority)
(Also see Joint Surveillance, MERSHIP Tracking.) Many Navy missions require covert tracking. The ability to detect, track and monitor small craft with low profiles and small or semi-submerged craft is important. However, the issue extend to other larger craft that might be involved in evading embargoes. The problem includes separating suspect craft from friendlies and neutrals in the cluttered littoral environment.

SPACE & ELECTRONIC WARFARE/
INTELLIGENCE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

QUARTILE

COMMON TACTICAL PICTURE

Attributes   I

    Timeliness

    Accuracy

    Completeness

Functions   I

    Data Management

        Data Fusion / Correlation (Organic to Non-organic)

        Data Retrieval / Dissemination (includes scalability)

        Data Update

        Analysis Aids

    Combat ID

        Non-Cooperative ID

        Positive Hostile ID

        Cooperative ID

    Display

        Scalable

    Commonality of Mapping, Charting, and Geodesy (Navigation)

CONNECTIVITY

Attributes   I

    Data Transfer Rate

    Interoperability

    Accessibility

    Timeliness

    Reliability

    Security

    Survivability

Functions   II

    Dynamic Network / RF Management

    Multimedia Services

    Adaptable with Commercial Services

BATTLE MANAGEMENT
Attributes   I
Sensor-to-Shooter Construct
Scenario Projection / Courses of Action
Multi-Level / Multi-Mission
Joint / Coalition / Interoperable
Real Time Display
Collaborative / Distributive
Dynamic Updating
Functions   II
Multi-Level Mission Planning (Unit, Group, Theater, Coalition)
Spectrum Management and Vulnerability Assessment
Mission Assessment
Execution
Real Time Mission Management
Integration of C4I / CDS

COUNTER C2 / C2 PROTECTION
Disrupt   I
Communications
Sensors
Cognitive Processes
Infrastructure
Identification
Data Bases
Processor Disruption
Navigation
Deceive   II
Communications - Intrusion, Manipulation, Insertion
Data Bases - False Data
Sensors (Adversary/Other)
Identification
SIGINT
Navigation
Processors
Population
Deny   II
International Sensors (Selective)
International COMMS

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COUNTER C2 / C2 PROTECTION (cont.)

Protect   **II**
- Denial
- Deception
- Destruction
- Disruption

Exploit   **III**
- COMMS
- Data
- Sensors

Destroy   **III**
- Communications
- Sensors
- Electronic Infrastructure
- Infrastructure
- Environmental Systems

C2W PLANNING AND ANALYSIS

Determine C2W Effect   **II**
- C2 System
- Decision Maker
- Warfighting Force
- Infrastructure
- Populace

Model Enemy Decision System   **III**
- Responsiveness/Readiness
- Functionality
- Structure
- Culture

Own Decision System   **III**
- Data Bases
- Visualization / Display
- Auto Analysis
- Info Analysis (Human)

Sensors   **III**
- Locate / ID Critical Nodes
- Radiated Signatures
- Passive Sensor
- Land Line Location
- Remote Land Land (Read)

Stimulators   **IV**

ENABLERS

Appendix 5

Strategic Deterrence

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
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STRATEGIC DETERRENCE

5-A <u>THEATER MISSILE DEFENSE (HIGH Priority)</u>
Littoral warfare exposes CVBGs and forces deployed ashore to the TBM. Regional powers already possess TMD capability , including conventional warheads and WMD (see Joint Littoral description). This problem statement extends the need to include the strategic threat within the larger AOR (vice strictly the littoral during localized operations). As before, an organic capability to defeat this threat is needed, shortly after launch or before apogee.

5-B <u>COOPERATIVE ENGAGEMENT CAPABILITY - CEC (HIGH Priority)</u>
Today's battlespace is compressed in time and stretched in space. When coupled with stealthy, high-speed threats, this changed battlespace demands a quicker, more effective way to engage incoming weapons. With sensors and engagement capabilities spread over multiple platforms, an integrated system is needed to optimize search, detection, tracking and engagement options.

STRATEGIC DETERRENCE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
INFORMATION ARCHITECTURE AND MANAGEMENT	
Surveillance	I
Situation Assessment (Near Real Time)	
I & W	
Locate (includes Mobile Targets)	
Monitor (includes Tagging)	
Detect (includes Mobile Targets)	
Verify	
Detection and Classification	I
Sensor Data Fusion	
Sensor Development, Selection, & Optimization	
Information Dissemination	
Attribute Determination	
IFF	
Targeting	II
Timely	
Target List Priorities	
Target Location Consistent with Weapon CEP	
System Nodal Analysis	
Planning	II
Responsive/Adaptive/Flexible	
Modeling, Simulation, and Decision Aids	
Near Real Time	
Interactive	
Collaborative	
Intelligence	III
Military Capabilities (Red)	

SEW

    C4   **I**

        Counter-C4

        C4-Protect

    Assured Communications Connectivity   **I**

        Blue

        Red / Blue

        Red to Red

    Planning   **III**

        Plan/Execute/Assess

        Exercise/Rehearse

SURVIVABLE NUCLEAR FORCE

    Platform Survivability (surface and subsurface)   **I**

        Stealth

        Acoustic/Non-acoustic ASW Advances

        Countermeasures/Counterweapons

        At Depth Communication and Navigation

        Tactical Decision Aids

        Standoff Delivery Systems

        Design In

    Command and Control   **I**

        Timely Responsiveness to Target Set Changes (includes mobile targets)

        EMP Hardness/Survivability

        Assured Response

    Technology Sustainment   **II**

        Weapon System Life Extension/Shelf Life

        Tech Base Support (Core Critical)

        Modeling, Simulation, and Prototyping

DEFENSIVE SYSTEMS

    Active Defense (TBMD, TMD, WMD Neutralizing Systems, etc.)   **I**

    Passive Defense (Suits, Masks, Body Armor, etc.)   **II**

MUNITIONS

Kill Mechanism   II
    Soft Kill
    Machine Kill
    Hard Kill

Penetrating   II
    Hardened Targets
    Partitioned Targets

Precision Delivered   III
    GPS-Quality Accuracy
    Timely

Unconventional   III
    Non-Lethal
    Lethal

Standoff   III
    Outside Area of Engagement
    Unmanned Systems
    Stealth
    Speed/Altitude

Biochemical Neutralization   IV

JOINT/COMBINED OPERATING CAPABILITIES

Communications   II
    Interoperable (language/cultural barriers) (protocol differences)
    Multi-level Secure (originator and user independent)

Planning Interoperability   III
    Real Time Interface
    Tactical Decision Aid

Functional Standardization   IV

Complementary/Supplementary/Substitutable System Capabilities   IV

STRATEGIC LIFT

Sea   IV
    Speed
    Adequate Capacity

Air   IV
    Adequate Capacity
    Speed

Appendix 6

Maritime Support of Land Forces

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
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MARITIME SUPPORT OF LAND FORCES

6-A SEALIFT CAPABILITY (MEDIUM Priority)
Advanced/improved air or surface craft are needed, to include a strategic lift vehicle and surge sealift capability.

6-B VISIBILITY OF EQUIPMENT, MATERIALS & SUPPLIES (MEDIUM Priority)
Naval Expeditionary Forces (NEFs) must transit from CONUS or prepositioned sites to the Amphibious Objective Area (AOA). These forces must provide the right equipment and supplies, in the correct amounts, to ensure ready combat forces can be inserted into and sustained in a hostile environment. In any large operation, the supplies and equipment will depart from several ports on many different ships. When they all arrive in the AOA, it is difficult to locate any individual piece of equipment or supply item. This makes sustainment difficult and jeopardizes landing forces. NEFs need the capability to identify, locate and track equipment, materials and supplies during transit. They also need the capability to access the needed supplies and move them to the combat element.

MARITIME SUPPORT OF LAND FORCES ROUND TABLE I: FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
JLOTS SYSTEM IMPROVEMENTS	
Dry and Liquid Cargo Throughput	I
Increased Sea State Operations	
Increased Stand-Off Distances	
Transition to Full Port Facility	
Advanced Modeling / Simulation	I
Cargo Throughput Systems	
Platform Design	
Operations and Acquisition Strategies	
Deployment	I
Interoperability (Incl. C4I)	II
Retrieval	III
FUTURE SEALIFT CONCEPTS	
Throughput (speed x payload (weight, volume, foot print))	I
Offload	
JLOTS	
Fixed Port	
Onload	
JLOTS	
Fixed Port	
Regeneration	
JLOTS	
Fixed Port	
Underway	
Material Movement	I
In Transit Visibility	
Storage	
Selective Offload, Pierside/In-stream	
Environmental Controls (Cargo Preservation)	
Advanced Modeling / Simulation	I
Cargo Throughput Systems	
Platform Design	
Operations and Acquisition Strategies	

FUTURE SEALIFT CONCEPTS (cont.)

Merchant Ship Utilization	**II**
Interoperability incl. C4I	**II**
Ship Deactivation	**IV**

SUPPORT SYSTEMS

Salvage **I**
- Combat Salvage
- Towing & Rescue
- Search & Recovery
- Pollution Abatement

Maintenance **II**
- JLOTS
- Ship

Repair **III**
- JLOTS
- Ship

COMBAT LOGISTICS FORCE

Throughput (speed x payload (weight, volume)) **I**
- Offload
  - *UNREP*
  - *Fixed Port*
- Underway
- Onload
  - *UNREP*
  - *Fixed Port*
- Retrograde/Consolidation
  - *UNREP*
  - *Fixed Port*

Material Movement **II**
- In Transit Visibility
- Storage
  - *Selective Offload, Pierside/In-stream*
  - *Environmental Controls (Cargo Preservation)*

Advanced Modeling / Simulation **III**
- Cargo Throughput Systems
- Platform Design
- Operations and Acquisition Strategies

Merchant Ship Utilization **III**
Interoperability incl. C4I **IV**

OFFSHORE BASING

Throughput (speed x payload (weight, volume, foot print))	**II**
Onload/Offload	
Base to Ship/Ship to Base	
JLOTS	
Base to Aircraft/Aircraft to Base	
Linking/Configuration	**III**
Interoperability incl. C4I	**III**
Material Movement	**IV**
In Transit Visibility	
Storage	
Selective Offload	
Environmental Controls (Cargo Preservation)	
Transit	**IV**
Station Keeping	**IV**
Multiple Support Functions (e.g. Medevac)	**IV**
Maintenance Functions	**IV**

SURVIVABILITY / PROTECTION (OPEN OCEAN AND LITTORAL)

Vulnerability	**III**
Damage Sensing / Control	
Passive Protection	
Susceptibility	**IV**
Self-Defense Measures (HK, SK, NK)	
Chem/Bio/Rad Defense	

Appendix 7

Forward Presence

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES

OCTOBER 1994

FORWARD PRESENCE

7-A ENVIRONMENTAL COMPLIANCE (HIGH Priority)
The reality of doing business overseas involves complying with foreign environmental regulations and host country sensitivities (i.e., restrictions associated with night landing practice in Japan, limited opportunity for overseas low level training areas, environmental concerns associated with port visits, etc.). U.S. ships and aircraft must comply with international regulations in order for the Navy to have a viable Forward Presence. (See environmental CTIs in other areas.)

7-B CAPABILITY TO MOVE NAVAL FORCES ANYWHERE IN A TIMELY MANNER
(See comments associated with Strategic Sealift and Protection.)

7-C OPTIMIZED JOINT AND COMBINED FORCE INTEROPERABILITY
(See comments associated with Joint SEW/Intelligence.)

7-D ENABLE FORCE DEFENSE
(See comments associated with Joint Strike Warfare.)

FORWARD PRESENCE ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
CAPABILITY TO PROJECT POWER BY PROVIDING THE PRESENCE OF A NAVAL FORCE SUITABLE TO THE MISSION	
Effectively Engage Targets	I
Time critical response	
Sustainable fire power	
Deep strike	
Minimize collateral damage	
Proper munition mix	
Measured response	
Non-lethal weapons	
Non-attributable munitions	
Control Of Key Terrain	I
Self sufficiency of forces	
Survivability	
Enhance mobility/counter-mobility	
Interface with local infrastructure	
"Instant ambassadorship"	
Maritime Intercept Ops (E.G., Blockades / Embargoes / Quarantines)	I
Tag and track	
Non-invasive inspection	
Non-lethal control	
Naval Operations Other Than War	I
"Swords that plow" (e.g., peace making / keeping / enforcement, disaster relief, humanitarian assistance)	
Sea-based support of ashore operations	
Conduct Exercises	II

CAPABILITY TO MOVE NAVAL FORCES ANYWHERE IN A TIMELY MANNER

Platform Availability	I
Functional suitability/flexibility/responsiveness	
Force size and capacity	
All Weather, All Sea State Capability	I
Unimpeded transit	
Exploitable METOC	
Clandestine Transit Capability	II
Dynamic signature control	
OPSEC/Deception	
Transit Unconstrained By Logistics Support	II
Infrastructure Availability	III
Overseas	
Domestic	
Political Support	III
Domestic support	
Regional/host support	
International/global support	
Transit Planning	IV
Support requirements	
Populate and maintain databases	
Resource selection and allocation	
Route selection	

BATTLESPACE DOMINANCE (TRANSITIONAL)

Air Superiority (Area)	I
Surface Superiority	II
Space And Electronic Warfare Superiority	II
Subsurface Superiority	II

CAPABILITY TO SUSTAIN NAVAL FORCES ANYWHERE IN A TIMELY MANNER

Minimize Logistics Footprint Without Loss Of Capability	I
Logistics-free systems	
Reduction in personnel requirements	
Improved economy of energy consumption	
Reduction in equipment size	
External prepositioning	
Live off the environment without adverse effects	

CAPABILITY TO SUSTAIN NAVAL FORCES ANYWHERE IN A TIMELY MANNER (cont.)

Maintenance Self-Sufficiency   I
Reduced complexity of maintenance
Fault-tolerant systems
Maximize MTBF
Self-repairing equipment
Component commonality (family of components)
Remote on-line diagnostics

Ensure Unit And Individual Proficiency Through Training   III
On demand
Customize for mission and environment
Customize for individual

Just In Time Logistics   III
Selective/responsive pull
Automated supply visibility
Supply sufficiency
Logistics push

Maintain Quality Of Life And Performance Levels   IV
Maintain performance proficiency
Medical
Personnel management (replacement & personal crisis)
Steady-state morale (e.g., overseas commissaries, schools, child care)

ENABLE FORCE SELF DEFENSE

Air Defense   I
Defeat the arrow
Cruise Missile
Air to Air
TBM
Directed Energy
Rocket (incl. chem/bio)
Gun Fire
Aircraft Bombs
Aerosol

ENABLE FORCE SELF DEFENSE

Air Defense (cont.)   I

Defeat the archer (launcher)

Aircraft

TELs (Transporter Erector Launcher)

Subsurface Craft

Surface Craft

Land Based Fixed Site

Multiple Warhead TBM

Artillery

Man Portable

Space Based

Surface Defense   II

Defeat the Arrow

Cruise Missile

Mines

Torpedoes

TBM

Rocket (incl. chem/bio)

Aircraft Bombs

Directed Energy

Gun Fire

Aerosol

Mammal delivered munitions

Defeat the Archer

Aircraft

Subsurface Craft

Surface Craft

Land Based Fixed Site

TELs (Transporter Erector Launcher)

Underwater Fixed Site

Artillery

Multiple Warhead TBM

Tanks

Space Based

Man Portable

Mammal

ENABLE FORCE SELF DEFENSE (cont.)

Force Survivability (Platforms And Systems)   **II**

Vulnerability

Damage resistance

Damage control

Susceptibility

Reduced Signature

Threat avoidance

Platform agility

Subsurface Defense   **IV**

Defeat the arrow

Mines

Torpedoes

Depth Charges

Directed Energy

Mammal delivered munitions

Defeat the archer (launcher)

Subsurface Craft

Aircraft

Surface Craft

Underwater Fixed Site

Land Based Fixed Site

Mammal

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MAINTAIN C4I SUPPORT (ACROSS ALL OTHER GOALS)

Timely, Tailored, Common Situational Awareness   **II**

Determine hostile intent

Information pull

Perfect operator knowledge

Presentation

System-based risk management

Processing

Information push

Joint/Combined Assured Connectivity   **III**

Adaptive architecture

No language barrier

Unexploitable by unauthorized users

Provide Surveillance   **III**

Acquire (integrate and fuse)

Export (data or knowledge)

All Source Intelligence (Timely Receipt And Dissemination)   **III**
Information Management   **IV**

Fuse, process, assess and disseminate

Decision aids

Planning

Unexploitable by unauthorized users

Maintain data bases

Automatic sanitization

Command And Control Warfare   **IV**

C2-protect

Counter-C2

OPTIMIZED JOINT AND COMBINED FORCE INTEROPERABILITY

Seamless Command And Control   **II**
Coordinated Doctrine   **III**
Proficiency In Operations/Exercises   **III**
Functional Control   **IV**
Seamless Logistics   **IV**

ENVIRONMENTAL STEWARDSHIP

Operations Unimpeded By Environmental Issues   **IV**
Maintain Health Of Own Forces   **IV**
Waste Management (Reduce Expendables)   **IV**

Appendix 8

Readiness

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

READINESS[1]

8-A MAINTENANCE (HIGH Priority)

Condition-Based Maintenance. Scheduled maintenance for many ships and aircraft systems consume scarce manpower and equipment resources, impacting availability of maintenance capability and ultimately ship readiness. Unnecessary maintenance often adds to the costs of handling and disposing of hazardous waste also. Processes and systems are needed for determining the physical condition of systems (especially electro-mechanical systems), either on line or off line, that signal when preventive maintenance is required. Sensors, neural networks, vibration monitors/analysis and fluid quality test equipment or monitors are examples of technologies that may be applied.

Ship and Aircraft Corrosion Reduction and Control. Corrosion of ship and airframe internal spaces, bulkheads at deck bulkhead seams, electrical surfaces (i.e., grounding points), sea water piping systems, tanks, voids and bilges require frequent maintenance. Stripping, surface preparation and repainting are costly, occupy scarce resources, impact readiness and add to the hazardous waste problem. New or alternate materials more resistant to corrosion and fouling are needed for new/replacement systems. New protective coatings are needed plus new, faster and less expensive stripping and surface preparation techniques for maintenance. New coating materials should be: anti-fouling hull coatings; environmentally safe; applied using equipment/techniques that are not hazardous to personnel or the environment.

Composite and Low Observable Material Repair. Low observable materials are becoming more common throughout fleet aviation. We need the capability to repair them at shipboard intermediate maintenance activities with environmentally safe materials and processes. Repairing composite materials is difficult and costly. Repair is impossible at some levels of maintenance thus causing repairs to be performed at higher maintenance levels which further adds to cost. Composite materials repair equipment, techniques or materials are needed that make repair possible at low (operational) maintenance levels. A new capability is required to repair the composite to original specifications with simple equipment, and be safe for the user and the environment.

Improved Reliability of Mechanical Systems. Frequent repair of leaky seals, gaskets and other common components is very time consuming and impacts availability of maintenance personnel and ship readiness. Improved reliability of common ship and aircraft mechanical and fluid components will reduce overall maintenance workload and costs.

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[1]CTI was titled "Readiness, Support & Infrastructure." To reflect structure of JMA/SAs and S&T Round Tables, contents are split between Readiness (Chapter/Appendix 8) and Support and Infrastructure (Chapter/Appendix 9).

READINESS ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

QUARTILE

DEVELOP PROCESSES AND TECHNOLOGIES THAT INCREASE THE EFFICIENCY AND DECREASE THE COSTS OF PERFORMING MAINTENANCE

Reduce inspection requirements and perform maintenance based on a system condition; develop prognostic technologies and methodologies for predicting failures including probable time to failure   **I**

    Automated non-intrusive diagnostics

        Built in

        Remote

    Ad hoc data query / data sharing

Design-in increased reliability, maintainability, and availability e.g.: interchangeable systems, modular systems, non-fluid power lubricating and cooling   **I**

Improve methods to perform maintenance at most effective level   **I**

Eliminate the requirement for equipment removal for testing and calibration e.g.: miniature calibration and test equipment, interactive interfaces between multiple pieces of equipment, remote automated test and calibration, self-calibration and test   **II**

Develop new techniques/materials to eliminate corrosion/fouling   **II**

    Materials and coatings engineered for the life of the system

    Low cost / manpower surface preparation

    Alternative concepts for corrosion protection

    Environmentally benign internal / external anti-fouling

    Non-surface preparation

    Non-intrusive detection

Develop processes and technologies that support joint and coalition interoperability   **II**

Design systems for improved technology insertion and preplanned product improvement   **II**

    Flexible design interfaces (on-line insertion of new systems)

    Total life cycle cost analysis tools

DEVELOP AND IMPLEMENT A SEAMLESS, INTEROPERABLE LOGISTICS CAPABILITY

Standardized, adaptable, integrated logistics support system   I

Decision analysis support system (integrated maintenance, supply, configuration and data)

Single, simplified, standardized accounting (property & financial) system for ashore / afloat assets

Total asset visibility and accessibility from manufacturer to end user

Real time interface with transportation system

Develop a real-time design/logistics interface that assures products reflect   III
actual system configuration

100% accuracy among product, technical & training manuals, maintenance capability, piece part

In situ validation

Automated, simultaneous, low cost, rapid, concurrent update

DEVELOP FLEXIBLE, ACCURATE, MEANINGFUL MEASURES OF EFFECTIVENESS FOR READINESS

Develop MOEs for training	I
Establish mission / readiness relationships	I
Develop capability to assess impact of deviation from planned execution on readiness	I
Develop quantitative mission and performance criteria	IV
Develop performance measure information infrastructure	IV

PREVENT ALL CLASS A AIRCRAFT MISHAPS

Eliminate human cause factors   I

Provide a manageable cockpit workload for all scenarios

> *Full time tactically integrated Ground Collision Avoidance System*
>
> *Information assimilation and integrated workload planning*
>
> *Adequate simulators/training devices (e.g., NVG's)*
>
> *Mid-air collision avoidance system*
>
> *Adequate aircrew displays*
>
> *Improved software safety analysis tools*

Training

> *Air crew coordination training*
>
> *Human factors training*
>
> *Mid-air collision avoidance*
>
> *G-LOC prevention training*

Risk assessment / risk management tools for aviation evolutions

Ergonomic design

> *Night Vision Device Integration*
>
> *Ease of use*
>
> *Design escape system for physically smaller population*

Maximize survivability/minimize damage   I

Improved crash survivability for HELOS and VERTOL

Provide expanded emergency escape envelope

Provide de-lethalized cockpit and crew stations

Provide stable HELO buoyancy system

Predictive causative factor correlation for determination of potential safety hazards

Provide low combustibility fuels and fuel systems

Provide adequate fire suppression and reflash systems

Provide a non-flammable and non-toxic hydraulic fluid that is compatible with existing systems

Provide improved fuel containment

Provide remote sighting capability for gearbox oil level

Meet requirements for OBOGS operations in a CBR environment

Eliminate material cause factors   II

Provide improved engine failure prediction

Provide improved failure prediction

Provide safer catapult gear energy delivery and control

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TRAINING

Ensure live fire training capability	**II**
Develop alternatives to live fire training	**III**
In situ training (reduced training time away from unit)	**III**
Common architectures for training systems	**IV**
Develop integrated risk assessment / risk management tools for all training evolutions	**IV**

MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPERATIONS

Ensure fuel availability and quality (without increasing cost) while   **I**
increasing performance, safety, and reliability
- Affordable, universal fuel
- Develop alternative fuels (e.g., non-perishable)
- In-line purification
- Portable, miniaturized fuel quality analyzer

Increase energy efficiency of Naval systems and equipment   **I**
- Improve fuel economy
- Real time efficiency measurement
- Effective bio-fouling control to increase hull efficiency

IMPROVED AT SEA SUSTAINABILITY

Decrease cycle time for resupply   **II**
- Decrease turnaround time for resupply ships e.g.: automated handling/ management, ship design
- Decrease frequency

Develop alternative methods to replenish all ships and boats e.g.:   **II**
refueling ships from submerged oilers, material compression/
expansion, logistics aircraft

Develop multipurpose logistics ships   **III**
- Interchangeable storage and weapons spaces

Develop at sea re-arm capabilities   **III**

Improve cargo/weapons handling from hold to weather deck   **IV**
- Mechanized capability (e.g., exoskeleton)

IMPROVED FORCES ASHORE SUSTAINABILITY

Develop alternative methods to resupply forces ashore e.g.:   **III**
  expeditionary airfields, forward logistics support sites

Decrease cycle time for resupply   **III**
    Decrease turnaround time for resupply (incl. automated handling/
      management, platform design)
    Decrease frequency (incl. weapons design)

Improve cargo/weapons handling from sea to shore   **III**
    Mechanized capability

Develop multipurpose logistics ships   **III**
    Interchangeable storage and weapons spaces

IMPROVE STOWAGE ECONOMY, ACCESSIBILITY AND INVENTORY CONTROL

Minimize stowage and handling demands   **II**

Develop improved shipping containers/systems for DON systems   **II**
  that are lightweight, high-strength, low-volume, shock absorbent,
  and non-toxic

Maximize stowage and handling capability   **III**
    Cargo handling deck
    Flexible storage
    Reduced explosive arc

IMPROVED SURVIVABILITY THROUGH DAMAGE CONTROL / PERSONNEL PROTECTION / FIRE FIGHTING

Maximize damage control / personnel protection capability   **II**
    Provide alternative breathing sources
    Provide expanded emergency escape capability
    Determine personal protective equipment requirements for protection
      from chemical, biological, and radiological attack
    Predictive causative factor correlation for determination of potential
      safety hazards
    Provide risk assessment / risk management tools for fire fighting and
      damage control evolutions to include operations in CBR environment
    Determine requirements for fire fighting / damage control in a CBR
      environment
    Meet requirements for operations in CBR environment

IMPROVED SURVIVABILITY THROUGH DAMAGE CONTROL / PERSONNEL PROTECTION / FIRE FIGHTING (cont.)

Maximize fire fighting capability   **IV**

Provide low combustibility fuels and fuel systems

Provide adequate fire suppression and reflash systems

Provide improved fuel containment

Effective, safe, and environmentally safe HALON and AFFF replacement

Provide fire source diagnostics systems (Rapid smoke suppression/ elimination)

Provide a non-flammable and non-toxic hydraulic fluid that is compatible with existing systems

Reduce weight of fire fighting ensemble

Heat Reactive Bulkheads

Provide full fire fighting potential of fog stream application

PREVENT ALL AFLOAT CLASS A MISHAPS

Eliminate human cause factors   **II**

Provide manageable bridge team workload;

> *Full time and tactically integrated collision and grounding avoidance system*
>
> *Information assimilation*
>
> *Adequate simulators/training devices*
>
> *Crew coordination*
>
> *Automatic station keeping*

Training

> *Provide bridge team coordination training*
>
> *Provide bridge team collision avoidance training*

Ergonomic design

> *Night Vision Device Integration*
>
> *Ease of use*

Risk assessment / risk management tools for shipboard evolutions

Eliminate material cause factors   **IV**

Provide failure prediction for arresting gear

Provide improved open-ocean and land control of target drones

PREVENT ALL OTHER MISHAPS

Eliminate human cause factors   IV

Reduce crew workload (Adequate simulators/training devices (e.g., NVG's))

Maximize survivability/minimize damage   IV

Predictive causative factor correlation for determination of potential safety hazards

Risk assessment algorithm for mission planning and execution

Provide adequate all weather emergency electrical power

Safer scuttles and hatches

Computer based program for safety input to ship design

Morphology independent design

Risk assessment algorithm to assess explosive waivers

Safety analysis of littoral warfare

Eliminate Material Cause Factors   IV

Provide low flammability fuels / reliable UAV engines

Provide all lighting condition capable displays

Provide joint/combined insensitive munitions

Provide safer catapult gear energy delivery and control

Provide triple redundancy HELO flight control systems

Provide Unmanned Air Vehicle (UAV) flight controls and recovery systems

Provide RAST cable visibility

Provide alternative cooling for avionics without impacting on OBOGS breathing air and engine performance

PERSTEMPO / DEPTEMPO - FORCE STRUCTURE BALANCE

Develop nonintrusive capability to track individual PERSTEMPO   IV

Appendix 9

Support and Infrastructure

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES

OCTOBER 1994

SUPPORT AND INFRASTRUCTURE[2]

9-A ENVIRONMENTAL (HIGH Priority)

Environmentally Safe Alternate Materials. The Navy uses many materials/chemicals that are environmentally unsafe and/or hazardous to personnel who work with them. The most pressing problem is the replacement of materials such as Halon (which is used in fire fighting systems) which are no longer being manufactured. Chlorofluorocarbons (CFCs) should be eliminated by 1995 and shipboard use of plastics should be reduced or eliminated by 1998 or sooner. A new fire fighting system/material is needed that is effective, safe to use and environmentally friendly. New refrigerants and chemicals for spray cans are needed to replace CFCs. Alternatives for plastic packaging materials and a non-toxic, environmentally safe lube oil replacement are needed. Use of heavy metals such as lead and zinc chromate should be eliminated. An improve flight deck non-skid material is needed, one with less silica.

Paint Analysis and Removal. A rapid and reliable portable test method is needed to determine if lead is present in paint on existing surfaces. Equally important are environmentally safe techniques and equipment for removing and disposing of lead-based paints.

Garbage Reduction and Disposal. Pending laws will require eliminating discharging many types of waste from ships by 1998. This same law allows no discharging in special areas which will probably grow in number in this same time frame. Accumulating garbage consumes valuable storage and working spaces. Transferring garbage to support ships will become an unworkable alternative as the fleet is reduced with dramatic impact on tenders. Several thermal destruction technologies have been investigated. Plasma arc pyrolysis has been assessed as one of the most promising for success in ship installations. However, it is estimated to take 8-10 years before production equipment may be available. Garbage disposal, or volume reducing, systems must e developed and deployed before the legislation is effective and negatively impacts on the Navy's ability to operate. Garbage treatment systems must comply with emerging regulations and be usable onboard ships of all classes.

Hazardous Material Management. A wide-area hazardous materials inventory information-sharing system is needed. Activities needing hazardous materials can obtain them from other activity who has materials near shelf-life expiration. Automated inventory, tracking and disposal documentation capability for hazardous materials is also needed to support this HAZMAT sharing capability.

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[2]CTI was titled "Readiness, Support & Infrastructure." To reflect structure of JMA/SAs and S&T Round Tables, contents are split between Readiness (Chapter/Appendix 8) and Support and Infrastructure (Chapter/Appendix 9).

SUPPORT AND INFRASTRUCTURE ROUND TABLE I: FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
DEVELOP SYSTEMS, PROCESSES AND TECHNOLOGIES THAT RESULT IN REDUCED MANPOWER	
More durable materials that require less maintenance	I
Improve concepts and technologies	I
Nonstandard supply process	
Improve aircraft turnaround efficiency	I
Reduce turnaround time	I
Concurrent single spot arming, refueling, and inspection	
MAXIMIZE UTILITY WHILE REDUCING LIFE-CYCLE COST OF DoN INFRASTRUCTURE	
Reduce investment for facilities	I
Alternative construction materials and concepts	
Conditioned based maintenance	
Construction materials / techniques resulting in one-time repair	
Timely condition assessment	
Develop cost effective concepts for multifunctional facilities	
Structural loading and response analysis models	
CURTAILMENT OF MILITARY OPERATIONS DUE TO SHIP & A/C COMPLIANCE REQUIREMENTS	
Substitutes for hazardous materials and processes	I
Control and management of shipboard solid and plastic waste	I
Improved marine sediment/dredge spoil decontamination, remediation, and reclamation	I
Control and management of shipboard non-oily liquid waste	II
Control and management of shipboard oily liquid waste	IV

LOSS OF BUDGET DUE TO COST OF COMPLIANCE

Improved sensing/monitoring of contaminants in marine environments	I
Improved marine sediment/dredge spoil decontamination, remediation, and reclamation	II
Control/reduce emissions from coatings, strippers, and cleaners	II
Standardized, regulator approved methods & protocols for conducting environmental marine risk assessment	II
Hazardous waste destruction ashore (e.g., lithium batteries)	II
Improved field analytical sensors, methods, & protocols to supplement traditional sampling and laboratory analysis	II
Ordnance waste minimization and disposal	III
Improved rocket motor propellant removal and reclamation/destruction	
Non-hazardous coatings, composites, processes and sealants	III
3-D models of contaminant fate and effects in the marine environment	IV
Control emissions from ordnance manufacturing and demilitarization	IV

MINIMIZE IMPACT OF ENERGY COST AND AVAILABILITY ON NAVAL OPERATIONS

Increase DON infrastructure energy efficiency	I
Increase Naval facilities energy independence	I
Active and passive, renewable, alternative energy	
Integrated thermal and electrical energy systems	
Multi-fuel use engines	

INFORMATION SUPPORT

Improved and cost effective links between forward deployed forces and shore establishments	I
Improved user access to specific data	II
Improved information throughput in all environments	II
Multi-level security	II
Person-to-person communications, worldwide, anytime, anywhere	II
Reduce the need for nontactical centralized information management commands	IV

HALON-RELATED LOSS OF FIREFIGHTING & EXPLOSION SUPPRESSION

Halon replacement for ships and vehicles	II

CURTAILMENT OF MILITARY OPERATIONS DUE TO AIR POLLUTION

Clean power plants for ships	I
Control emissions from all existing ship engines	II
Control jet and rocket engine emissions	III
Monitoring/sensing of toxic air emissions	III

LOSS OF T&E CAPABILITY

Effects of marine corps beach & surf-zone T&E	II
Effects of ship shock testing	III
Effects of weapon testing	III
Assessment/mitigation of impacts of specific operations on threatened and endangered species, marine mammals, and habitats	III
Determine effects of pollutants on threatened and endangered species and marine mammals	IV
Blast noise mitigation (on a test range)	IV
Technologies to reduce "incidental take" of marine mammals / threatened and endangered species	IV

LOSS OF BUDGET DUE TO COST OF RESTORATION

Improved marine sediment/dredge spoil decontamination, remediation, and reclamation	II
Improved sensing/monitoring of contaminants in marine environments	III
Improved field analytical sensors, methods, & protocols to supplement traditional sampling and laboratory analysis	III
Standardized, regulator approved methods & protocols for conducting environmental marine risk assessments	III
3-D models of contaminant fate and effects in the marine environment	III
Real-time in situ sensor including solvents, marine sediments, ordnance	IV
Atmospheric dispersion models	IV

R114-RELATED LOSS OF COOLING IN SHIPS

Non-CFC vapor compression cooling	IV

CURTAILMENT OF OPERATIONS DUE TO NOISE POLLUTION

Effects of acoustic emissions on marine mammals and threatened/ endangered species	IV

ACQUISITION SUPPORT

HEADQUARTERS AND COMMANDS (NO S&T REQUIREMENTS IDENTIFIED)

Appendix 10

Manpower and Personnel[3]

- **FY95 Round Table Functional Architecture**

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[3]No Fleet CINC Command Technology Issues were related to Manpower and Personnel S&T.

MANPOWER AND PERSONNEL ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

QUARTILE

EXTRACT CRITICAL INFORMATION UNDER COMPLEX AND
UNCERTAIN TACTICAL CONDITIONS

Presenting   I

    Tactical Visualization

    Multimedia Input/Output

    Alerting

    Immersive Interfaces

Cognitive/Perception   II

    Situational Awareness

    Modeling

    Characteristics

    Audition

Processing   II

    Fusion

    Distribution

IMPROVE ABILITY TO MANAGE THE PERSONNEL FORCE
STRUCTURE EFFICIENTLY AND COST EFFECTIVELY

Manpower Management   I

    Decision Support Aids

    Technological Changes

    Sea-Shore Rotation

    Crewing Concepts

    Right Sizing

    Gender Neutrality

Total Force Distribution   I

    Personnel Inventory Allocation

    Manning Readiness Determination

    Decision Support Aids

    Active/Reserve Assignment

    Issues Associated with Women in DoN

    Issues Associated with Diversity

    Civilian Substitution

    Training Reservation

    Outsourcing

IMPROVE ABILITY TO MANAGE THE PERSONNEL FORCE

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STRUCTURE EFFICIENTLY AND COST EFFECTIVELY (cont.)

Personnel Management I

  Decision Support Aids
  Compensation
  PERSTEMPO/OPTEMPO
  Career Advancement
  Right Sizing
  Tour Lengths
  Training Resource Management
  Gender Neutrality
  Skill Transfer
  Improved Advancement-in-Rate Tests

DESIGN AND ACQUIRE SYSTEMS OPTIMIZED FOR HUMAN USE

Standard techniques for presenting operational info II

  Effective info display methods
   Picture compilation
   Weapons launch
   Other
  Methods to develop/modify plans

Requirements Analysis II

  Match human capabilities to system functions
  Human-centric Design Approach
  System Decomposition

Operator Readiness II

  Embedded training /Advanced training on system
  Incorporate expert/knowledge for operations and maintenance
  Multiple-selective help levels

Error reduction in human-centric systems IV

  Extend fault tolerance & reconfigurability
  Transparent incorporation of hardware techniques

PLAN COMPLEX MISSIONS AND MAKE RAPID, ACCURATE TACTICAL DECISIONS

Individual &/or Collaborative Tactical Decision Making   I

Situational Assessment

Information accessing from multiple sources

Option evaluation

Response Selection

Team Coordination

ROE constraints

Individual &/or Collaborative Mission Planning   II

Mission Objectives definition

Intelligent Assessment

Course of action evaluation

Contingency planning

Resource allocation/utilization

Environmental assessment

Route Planning

ATTRACT AND RETAIN HIGH QUALITY PERSONNEL

Quality of Life   I

Pay/Personnel Issues

Compensation

Individual Career Development

Morale, Welfare, and Recreation

Family Issues

Health Care

Personal communication while deployed

Family Services

Child Care

Pregnancy

Single Parents

Dual Military Couples

Work Place Issues

OPTEMPO, PERSTEMPO

Standard Work Week

Promotions/Awards

Equal Opportunity

Housing Issues

Family Housing

Berthing

BOQ, BEQ

ATTRACT AND RETAIN HIGH QUALITY PERSONNEL (cont.)

Personnel Acquisition in a Dynamic Environment   I

     Compensation

     Recruiting Technology

     Demographics Change Predictions

     Recruiting Resources Determination

     Recruiting Diversity

     Propensity to Enlist

     Non-End of Active Service (EAS) Attrition

Retention   III

     Compensation

     Challenge and Stimulation (Personal Interest)

     Retention of Core Professional Talent

     Understanding Behavioral Science

CONTROL & MAINTAIN COMPLEX WARFIGHTING SYSTEMS

Manpower & Personnel   III

Communication   III

Platform and system control   III

Weapons delivery   IV

Logistics   IV

Diagnosis & Repair   IV

Sensor Operation   IV

Navigation   IV

IMPROVE SELECTION OF PERSONNEL AND THEIR CLASSIFICATION TO JOBS

Job Specification   II

     Task Analysis

     Redefining Ratings and Classifications

     Knowledge, Skills, and Abilities

Selection   III

     Aptitude Testing

     Proficiency Metrics

     Medical Standards and Screening

Classification   III

     Performance Models (Cost/Benefit, etc.)

     Matching Performance to Ratings & Specialties

     Integrating New Testing Techniques

     Classification System Simulation Models

IMPROVE THE DoN's CAPABILITY TO OPTIMIZE PERSONNEL DETAILING AND ASSIGNMENT DECISIONS

Execution   II

Develop Decision Aids

Make Optimum Personnel Transfer Decision

Delivery Mechanisms

Policy   IV

Develop Decision Aids

Formalize Projections For Personnel Management

MAINTAIN OPTIMAL PERFORMANCE IN EXTREME ENVIRONMENTS AND UNDER ADVERSE CONDITIONS

Dynamic Monitoring   III

Performance

Imbedded Operator Performance Checks

Biopsychometrics

Environment

Internal

Attention

Fatigue

Boredom

Trusting Technology

External

Workload

Secondary Job Requirements

Physical Environment

Interventions   IV

External

Automation

Maintain Optimum Physical Environment

Rotation

Internal

Stimulation

Alerts

Pharmacological

Selection/Training   IV

Stress Tolerance

Wellness

Stress Inoculation

Profiling

MAINTAIN OPTIMAL PERFORMANCE IN EXTREME ENVIRONMENTS AND UNDER ADVERSE CONDITIONS (cont.)

Performance Standards   IV

Performance Parameters
Performance Metrics

Appendix 11

Training

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES

OCTOBER 1994

MANPOWER, PERSONNEL AND TRAINING

11-A SIMULATION/STIMULATION EMBEDDED IN EXERCISES (HIGH Priority)
Funding for steaming to participate in exercises and travel to training ranges is becoming scarcer. Also, current training does not stress the operators like a real combat situation, resulting in unrealistic training. Training can be more cost effective if exercises can be augmented with realistic simulation and stimulation (preferred). There is a need to combine real-life training with realistic simulation and stimulation to make training more effective while reducing cost. There is also a need to advance technologies like virtual reality, making simulation more realistic. Improvements in embedded training, especially those tied to stimulation, are required. Realistic training also requires BG level and JTF level simulation and/or stimulation. Training should be based on the common/consistent tactical picture (see test under Joint Strike, Common/Consistent Tactical Picture).

11-B SHALLOW WATER TRAINING RANGE/CAPABILITY (MEDIUM Priority)
Proficiency and readiness depend on accurate and realistic training. Littoral warfare demands an improved shallow water training capability. One facet of such training is a shallow water training range, used by air, surface and submarine assets for training coordinated operations in mining, shallow water ASW, SOF, etc.

11-C TARGETS (MEDIUM Priority)
Realistic surface and aerial targets are required for crew training and proficiency. Realistic surface, aerial and submerged/submarine targets are required for crew training and proficiency.

TRAINING ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
EVALUATE / ASSESS PERFORMANCE	
External Process (Impact)	I
Fleet readiness impact	
Post-graduate skill competency	
Internal Process (Procedure)	III
Student / Team	
Course / Exercise	
Instructor	
DEVELOP STRATEGIES	
On demand / just in time	I
Examine methodologies	I
Instructional / Media options (learning theory)	
Technologically driven	
Cost benefit analysis	II
DELIVER INSTRUCTION	
Optimize for student / team	I
Optimize student / instructor interface	II
DEVELOP INSTRUCTIONAL MATERIALS	
Measures of effectiveness	II
Task analysis / objectives	II
Equipment	II
Media selection	III
Curricula (courseware)	III
PROFICIENCY	
Criteria	I
Currency (upgrade)	
Refresher	
Interval	
Diagnostics	II

MANAGE RESOURCES

    Planning and programming   **II**

        Infrastructure

        Manpower / End strength

        Funding

        Trade-offs

        Equipment

    Budgeting and execution   **II**

        Infrastructure

        Funding

        Trade-offs

        Manpower / End strength

        Equipment

DETERMINE REQUIREMENTS

    Needs analysis   **I**

        Subject matter expert/fleet input

        Validate requirements

    Develop training concept   **II**

        Initial

        Replacement

        Refresher

        Joint

PROVIDE FEEDBACK

    Architecture   **II**

    Input / Output criteria   **III**

    Users   **III**

INTEGRATE TRAINING ISSUES WITH:

    Acquisition policies / process   **IV**

    Manpower policies / requirements   **IV**

    Naval Doctrine and Tactics   **IV**

    Cross pollination / utilization   **IV**

        DON internal

        External

    Personnel policies / distribution   **IV**

Appendix 12

Medical

- **Command Technology Issues**

- **FY95 Round Table Functional Architecture**

MEDICAL ROUND TABLE I:
FUNCTIONAL ARCHITECTURE WITH PRIORITIES

	QUARTILE
INDIVIDUAL AND COLLECTIVE HEALTH PREVENTIVE MEDICINE IN NAVAL OPERATIONS	
Improve identification / prevention of new or reemerging military relevant diseases	I
Improve prediction/prevention of military relevant infectious diseases	
Determine effect of military work patterns on chemical, biological, & physical agent exposure	I
Determine optimal physical fitness profiles for naval service	I
Identify and evaluate reproductive hazards	I
Develop potable water contamination indicator technology	I
Improve toxicological tools for analysis of Navy specific hazardous materials	I
Characterize shipboard and other platform electromagnetic environments	I
Improve "surge" capability in vaccines and immunizations"	II
Develop expert systems for evaluation of work place surveillance and monitoring	II
Improve shipboard ventilation for environmental quality and disease detection	II
Improve measures and quantification of RF and microwave energy absorption in humans	II
Improve prevention / identification of persons at risk for adverse psychological responses	III
Develop treatment protocols for laser eye injuries	III
Determine permissible exposure limits for naval fuels	III

AEROSPACE MEDICINE

Reduce human factors risk to Aviation Personnel I

Identify common human factors associated with aviation mishaps

Develop predictive model of human error in aviation mishaps

Develop user-accepted means to prevent Controlled Flight into Terrain (CFIT)

Assess and validate existing programs of Aviation Human Factors Review (i.e., Human Factors Boards, Human Factors Councils)

Develop visual scan patterns as index of pilot skill development

Optimize pilot visual scanning performance

Develop deployable human impairment testing systems.

Improve cognitive performance monitors in flight operations.

Automatic pilot physiological monitoring

Develop human factors aspects of virtual environment displays used in naval aviation.

Human factors aspects of helmet mounted displays

Human factors aspects of mission rehearsal

Voice recognition/activation

Reduce risk to aviation flight-deck/flight-line personnel

Develop methods to reduce risk to flight-deck / flight-line personnel

Develop non-pharmacological countermeasures to fatigue

Provide fleet with shiftwork scheduling alternatives

Identify risk to flight-deck / flight-line personnel

Improve visual performance using multi-spectral devices. I

Identify basic physiological and performance effects of elector-optical devices.(including helmet mounted)

Improve field-of-view and resolution

Laser / agile laser eye protection

Lightweight and user friendly

Reduce visual distortion

Fully integrated performance of all the above with CBR protection

AEROSPACE MEDICINE (cont.)

Increase situational awareness/spatial orientation among aviation   **I**
personnel to reduce aircraft mishaps.

Provide method to screen for susceptibility to spatial
disorientation

Provide advanced training program for spatial orientation

Provide alternative methods for spatial orientation

Develop methods to enhance somatosensory inputs
(eg. vibro-tactile vest)

Investigate use of artificial horizons

Apply psychophysical and neurophysiological approaches to spatial
orientation.

Optimize countermeasures for air sickness and simulator sickness.

Validate existing Navy motion sickness desensitization program.

Determine etiology

Improve and validate current medical criteria for Naval Aviation duty.   **I**

Validate medical screening criteria for aviation duty.

Develop mechanism for evaluation of effects of therapeutic drugs on
aircrew performance.

Validate medications considered for use while flying.

Develop validated manikin / engineering model for cockpit development.

Determine anthropometric requirements for ejection

Provide gender specific requirements for ejection

Provide anthropometric requirements for cockpit

Provide necessary modifications to incorporate females ergonomically
into the cockpit

Reduce neck and back strain in combat aviators.

Develop next generation anthropometric criteria.

Develop gender-neutral occupational strength standards.

Maximize form fit and function of personal flight equipment for   **I**
protection from flight environmental stressors.(G's, thermal, noise,
laser, CBR, etc.)

Lightweight and user friendly (helmets, G-suits, boots, CBR gear, etc.)

Develop lightweight, user friendly, and reusable MOPP gear.

Enhanced hearing protection for high noise aviation environments.

Comfortable and lightweight cold water protection.

Comfortable and lightweight heat stress protection.

AEROSPACE MEDICINE (cont.)

Determine the partial pressure schedules/effects for high altitude, high   **III**
    G positive pressure oxygen

      Develop schedules for repetitive altitude exposures

Develop gender/race neutral crew selection   **III**

      Develop computer based Aviation Selection Test Battery.

      Validate computer based psychomotor testing (CBPT)

CROSS-PLATFORM NAVAL MEDICAL ISSUES

Develop single-dose multivalent vaccines for operationally relevant   **I**
    diseases

Improve visual performance using multi-spectral devices.   **I**

      Identify basic physiological and performance effects of elector-optical
        devices (including helmet mounted)

      Laser / agile laser eye protection

      Improve field-of-view and resolution

      Lightweight and user friendly

      Fully integrated performance of all the above with CBR protection

      Reduce visual distortion

Improved management of operational casualties   **I**

Identify issues associated with women at sea   **I**

      Evaluate epidemiological data and provide tools regarding medical
        impact of women at sea

Identify issues associated with women in aviation   **II**

      Provide user-accepted urinary collection device(s)

      Establish impact acceleration limits for females (cadaveric studies)

      Hazards to reproduction, particularly noise/vibration and ionizing/
        nonionizing radiation

      Ejection escape induced hazards

Develop training simulators for medical practitioners   **II**

Minimize thermal effects on human physiology (undersea/aerial/surface   **II**

Improve capability of shipboard and field anesthesia machines   **II**

Simplify laboratory procedures for independent duty corpsmen (IDC)   **II**

Develop countermeasures for performance degradation during   **II**
    sustained operations

      Investigate psychophysiological effects of countermeasures

Develop reagents with longer shelf lives, reduce refrigeration   **II**
    requirements

Improve predictive mechanics of psychological / sociological / medical   **II**
    adaptability & screening for special duties

CROSS-PLATFORM NAVAL MEDICAL ISSUES (cont.)

Evaluate effects of photorefractive keratectomy on mission specific performance	III
Investigate the use of simulators to enhance physiological training for all personnel	III
Determine optimum fluid resuscitation as a function of time to definitive surgical intervention	III
Improve prevention and treatment of dental emergencies	IV

EXPEDITIONARY FORCE MEDICINE (FMF)

Improve potable water contamination detection technology	I
Develop lightweight, user friendly, and reusable MOPP gear.	I
Improve Aeromedical Evacuation capability from deployed units afloat and ashore.	I
Optimize physical fitness programs to sustain / enhance performance.	I

Eliminate injuries due to physical conditioning programs.
Develop alternative recruit physical training requirements.
Develop alternative recruit physical training program.

Develop early detection and location capability of personnel incapacitation and injury.	II
Develop an orally administered insect repellent	II
Investigate the use of aircraft simulators to enhance physiological training for all aircrew.	II

UNDERSEA MEDICINE

Develop methods to decrease / treat decompression sickness	I

Identify basic mechanisms of decompression sickness
Increase multi-level repetitive diving duration & decrease decompression requirements

Develop methods to predict / prevent oxygen toxicity	II

Identify mechanisms of oxygen toxicity

Identify contaminants & their effects in closed space environments	II
Minimize effects of thermal stress in immersion	II
Identify the effects and develop protection for low-frequency sound in the water	III
Optimize work-sleep cycles associated with submarine service	III
Identify and resolve adverse effects related to disabled submarine scenarios	IV

SURFACE MEDICINE

Improve battle dressing station and medical department equipment; particularly improve exam tables, including accommodation of females	I
Improve mass casualty management (to include war game elements of modeling & simulation)	II
Provide filmless, digitized, x-ray capability for all Naval vessels	II
Provide small, sturdy x-ray unit for service aboard IDC serviced vessels	
Shipboard manufacture of parenteral fluids	II
Improve on-hull communications and information management in the medical facility	II
Provide medical O2 manufacturing capability for all Naval vessels	III
Evaluate validity of color vision requirement for shipboard personnel	IV

SPECIAL OPERATIONS WARFARE MEDICINE
(SEALs, EOD, MARINE RECON)

Define and provide optimal medical care in special warfare scenarios	III
Optimize unaided and aided night vision in special operation missions	III
Improved MOPP Gear	III
Minimize effect of changes in environmental or physical conditioning on special warfare performance	III
Integrate O2 and CO2 machine sensors with human sensors for multi-level diving	III
Laser protection under all special warfare diving scenarios	III
Develop training system to support sustainment training of special operations forces	III
Improve medical translator capabilities for special warfare use	IV
Minimize effect of special warfare training on operational readiness	IV
Define nutritional requirements to maximize special warfare performance	IV

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COMBAT CASUALTY CARE (PRESERVE HUMAN LIFE AND MANPOWER ASSETS)

Realtime / in-situ / portable life sign monitor	III
Remote sensing of medical data (vital signs monitor)	III
Greater availability of blood and blood substitutes	III
Minimize thermal effects on human physiology	III
Effective battlefield shock prophylaxis treatment	IV
Increase shelf life of resuscitative blood products	IV
Eliminate logistic burden for refrigerated storage	IV
Develop therapy for musculoskelatel injuries	IV
Effective battlefield treatment for hypovolemic shock	IV
Rapid non-invasive blood chemistry monitoring	IV
Rapid wound healing and debridement	IV
Develop organ replacement therapy	IV
Skin transplants for burns	
Traumatic single organ failure	
Reduced bulk fluid resuscitation technology	IV
Eliminate immunoreactivity in emergency transfusion	IV
Develop stem cell transfusion therapy	IV
Improved therapy of reperfusion injury	IV
Increase reconstitution throughput of blood products	IV
Enzymatic conversion to O type blood	IV
Compact organ replacement / support systems capability	IV

Navy Science & Technology Budget

Appendix 14

List of Acronyms

LIST OF ACRONYMS

A/D	analog to digital
AO	area of operations
AAA	anti-aircraft artillery
AAAV	advanced amphibious assault vehicle
AAW	anti-air warfare
AEW	airborne early warning
AFFF	aqueous fire fighting foam
AOA	amphibious operating area
ASTOVL	advanced short take-off, vertical landing
ASW	anti submarine warfare
ATDG	advanced technology demonstration guidance
ATO	air tasking order
BAT	brilliant anti-armor submunition
BDA	bomb damage assessment
BDI	battle damage information
BG	brigade
BLT	battalion landing force
C2W	command, control warfare
C4I	command, control, communications computers, Intelligence.
CBR	chemical, biological, radiation
CCM	counter countermeasures
CEP	circular error of probability
CFC	chlorofluorocarbons
CLF	combat logistics force
CLZ	craft landing zone
CNR	Chief of Naval Research
COA	course of action
CTI	command technology issues
CW/BW	chemical/biological warfare
DBM	data base management
DEPTEMPO	depot/deployment tempo
DIV	division
ECM	electronic countermeasures
EFI	electromagnetic field interference
EO	electro-optic
ESM	electronic support measures
FCS	fire control system
FLIR	forward looking infa red
FMS	foreign military sales
G&C	guidance and control
GPD	gallons per day
GPS	global positioning system
HARM	high speed anti-radiation missile

HM&E	hull maintenance and electronics
HMMWV	highly mobile multi-purpose wheeled vehicle
I&W	indications and warnings
I2R	imaging infrared
IADS	integrated air defense system
IFF	identification, friend, foe
IR	infrared
IRST	infrared search and track
ISAR	imaging synthetic aperture radar
ITV	in transit visibility
JLOTS	joint logistics over the shore
JMA/SA	joint mission area/support area
JMCIS	joint maritime command information system
JTF	joint task force
JTIDS	joint tactical information distribution system
JTN	joint targeting network
LABS	laser airborne bathymetry system
LAN	local area network
LCAC	landing craft, air cushioned
LCU	landing craft, utility
LIDAR	light detecting and ranging
LO	low observable
LOTS	logistics over the shore
LPD	low probability of detection
LPI	low probability of intercept
MC&G	mapping, charting and geodesy
MCM	mine countermeasures
MDU	mission data update
MEF	marine expeditionary force
METOC	meteorological and oceanographic
MEW	maritime expeditionary warfare
MHD	magnetohydrodynamics
MIW	mine warfare
MOE	measure of effectiveness
MPF	maritime preposition force
MPS	maritime preposition ship
NAVMETOCOM	Naval Meteorological Command
NCTR	non-cooperative target recognition
NOX	nitrous oxides
NSFS	Naval surface fire support
NVG	night vision goggles
OBOGS	onboard oxygen generating system
OMFTS	operational maneuver from the sea
OOB	order of battle
OPDS	offshore petroleum discharge system

OTH	over the horizon
PERSTEMPO	personnel tempo
PGM	precision guided munitions
PK	probability of kill
PTTI	precise time/time-interval
RAP	rocket assist projectile
RAST	radar absorbing structures technology
RF	radio frequency
RLT	regimental landing force
RMA	revolution in military affairs
ROE	rules of engagement
ROV	remotely operated vehicle
RTEM	real-time environmental measures
S&T	science and technology
SADARM	surface to air defensive anti radiation missile
SAR	synthetic aperture radar
SDV	swimmer delivery vehicle
SEW/I	space electronic warfare/ intelligence
SHF	super high frequency
SK	soft kill
SLOC	sea lanes of communication
SOCRATES	Special Operation Command Research, Analysis & Threat
SOF	special operations forces
STRG	S&T requirements guidance
TBG	technology based guidance
TBM	theater ballistic missile
TDA	tactical decision aid
TDD	target detection device
UAV	unmanned air vehicle
UNREP	underway replenishment
USTRANSCOM	U.S. transportation command
UUV	unmanned underwater vehicle
UV	ultra violet
VTOL	vertical take off and landing
VLO	very low observable
WMD	weapons of mass destruction